

■ NAVAL ARMS RACE ■ THE NEW AUTOMAKERS ■

■ HOW JAPANESE BUSINESS SHARES RISK ■

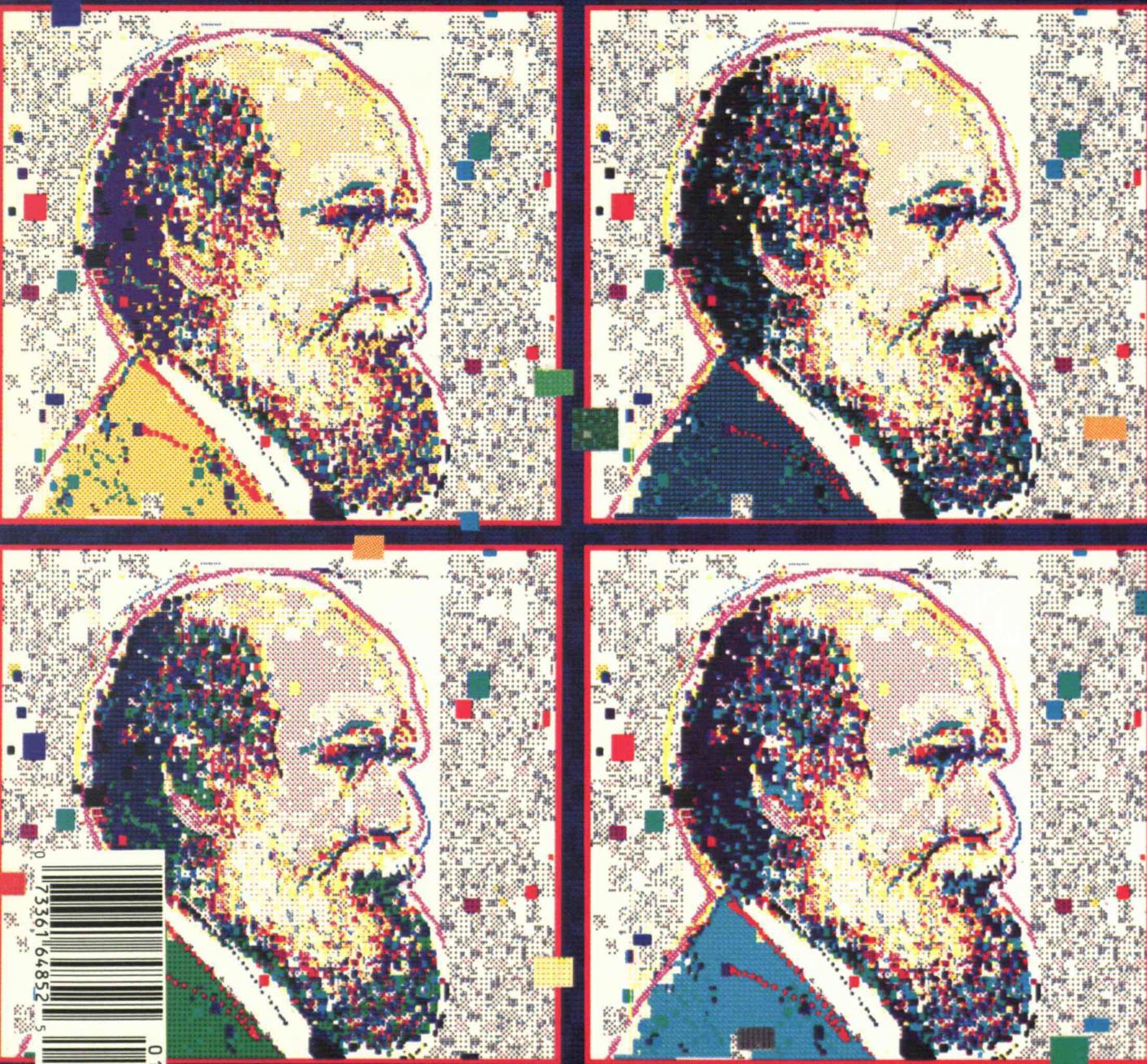
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BEYOND ARTIFICIAL INTELLIGENCE: COMPUTER SCIENCE LEARNS FROM DARWIN



technology review

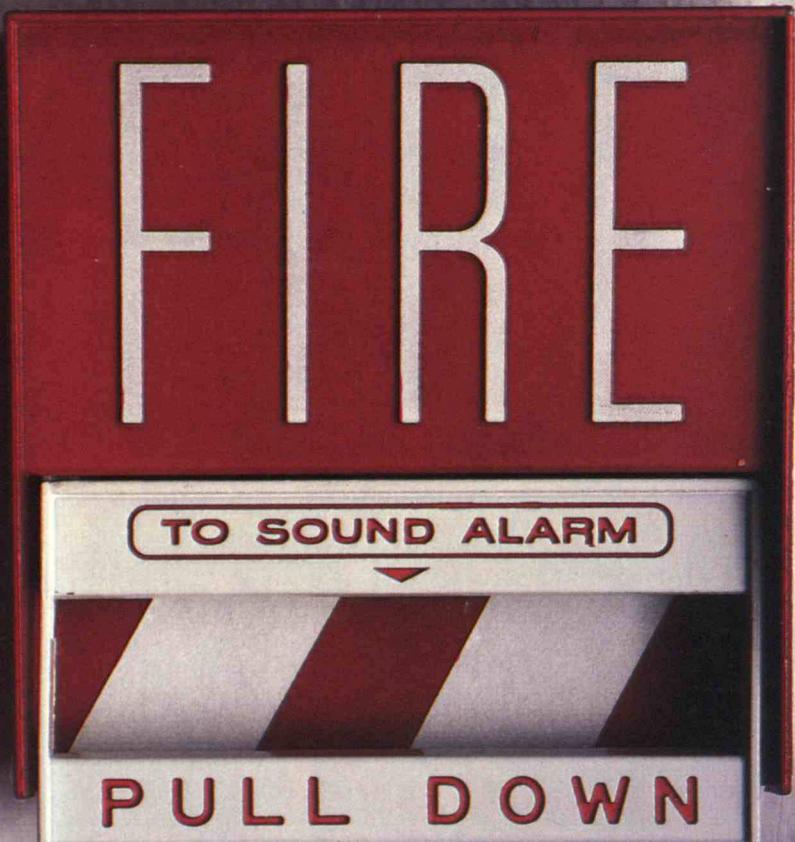
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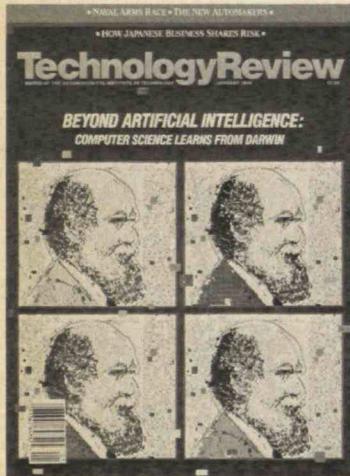
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MIT REPORTER

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Illustration by Glenn Johnson
Design by Nancy Cahners

PUBLISHER

William J. Hecht

EDITOR

Jonathan Schleifer

MANAGING EDITOR

Sandra Hackman

DESIGN DIRECTOR

Nancy L. Cahners

DESIGN/PRODUCTION MANAGER

Kathleen B. Sayre

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The M.I.T. Press

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*Former Dean of Faculty**Mount Holyoke***EDITOR EMERITUS**

John I. Mattill

FIRST LINE**FROM THE EDITOR**

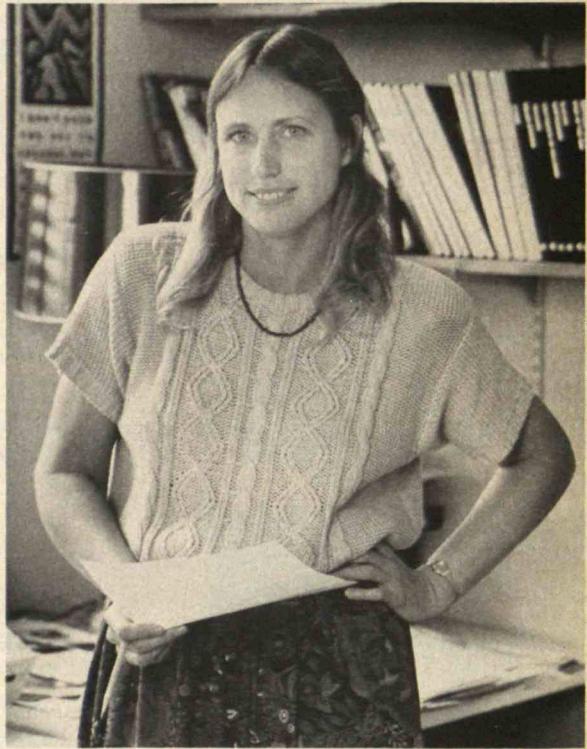
The Compleat Editor

THE first article I edited at *Technology Review*, not to be unkind to the author, took a lot of work. When I was done, other editors thought it much improved. Then back it came from the copy editor covered with scratches. Fortunately, she was as tactful as she was persistent, and we fixed numerous awkward phrases. But toward the end, she noted several contradictory statements. After scurrying to the original, I realized that I had no idea what the author was saying and that my editing had merely exacerbated the confusion. I prefaced my queries to the author with, "The copy editor says . . ." It was a phrase I have used often. It had the ring of inevitability, especially since the masthead did not reveal any individual as the copy editor.

I can now identify that former copy editor as Sandra Hackman. She was listed as associate editor, then senior editor, and now managing editor. Her astuteness will sharpen authors' manuscripts even more than in the past.

Sandra came to *Technology Review* after writing and editing science textbooks at a federally funded program called Project Outside/Inside, and editing at the Education Development Center. She defined the role of copy editor here—a more substantial job than elsewhere—and soon took on other responsibilities. She did increasing amounts of primary editing and soliciting of major articles and ran the book-review section. In recent years she has helped other editors with their work.

Sandra's knowledge of the subjects we cover, her sound judgment of articles, and her ability to turn the most cumbersome manuscript into concise prose (tactfully) make us grateful to have her as managing editor.

**Sandra Hackman**

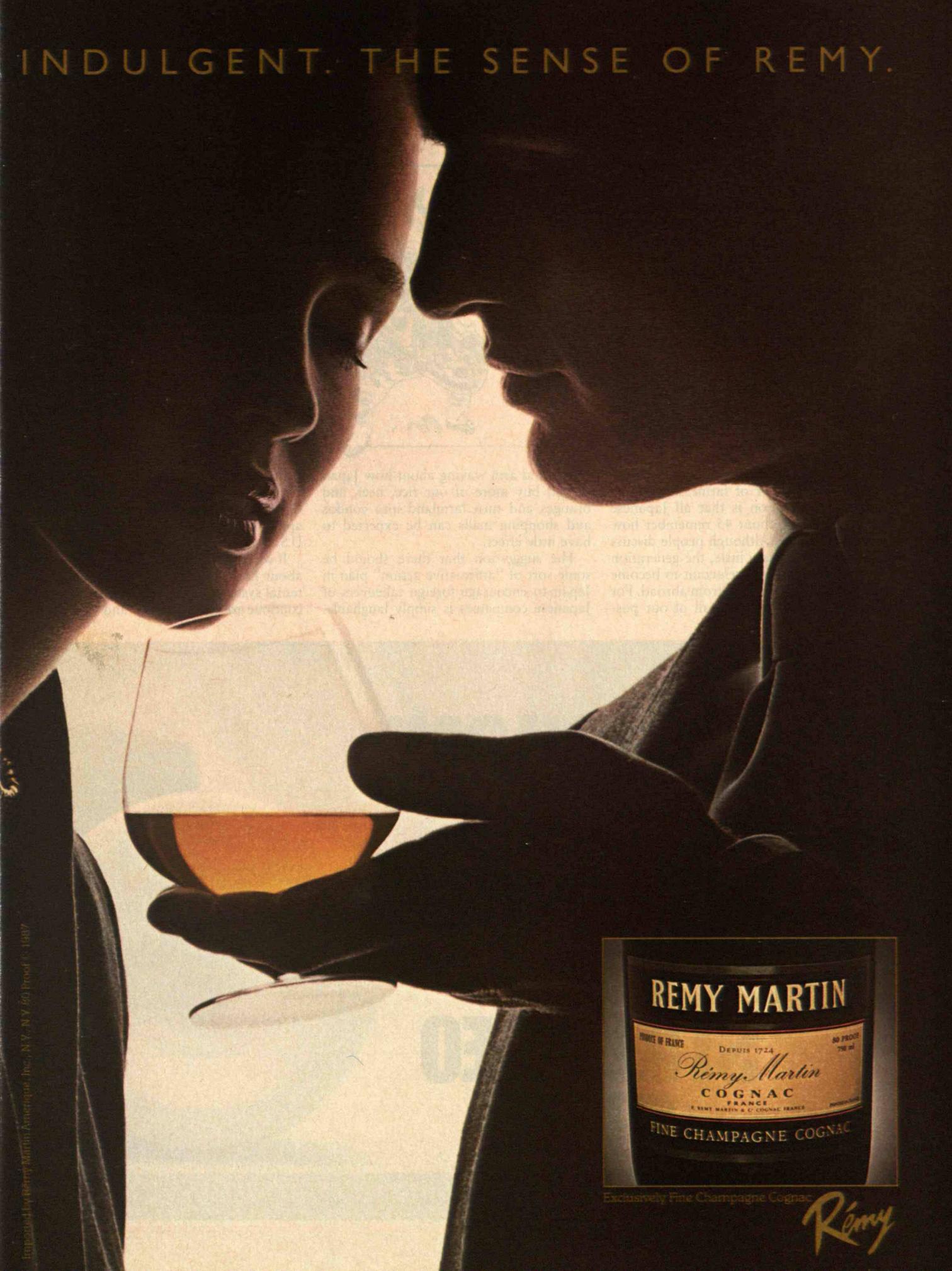
EDITORS hear more from readers who don't like articles than from those who do. Thus, we are glad to receive a letter from the Society on Social Implications of Technology (SSIT) of the Institute of Electrical and Electronics Engineers. The judges of the SSIT Award for Outstanding Service in the Public Interest found Samuel C. Florman's October 1987 column, "Engineering: An Ideal Profession for Idealists," persuasive. They decided this year to give their award to Benjamin Linder, an engineer discussed by Florman who was killed while building a small hydroelectric plant in Nicaragua.

Whatever one's politics, wrote Florman, "it is impossible not to have positive feelings about a young person from a well-to-do society assisting the people of a Third World nation. And this was a young person who chose to help not by waving placards in a demonstration, but by bringing his talents to bear against the oppression of poverty."



JONATHAN SCHLEIFER

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JAPAN, INC.

In "The Japanese View of Economics" (May/June 1988), Clyde Prestowitz sheds more light than perhaps he intended. It is appalling—but not surprising, given the history of the past eight years—that a former Reagan administration expert on Japan trade policy has such large gaps in his understanding of the cultural differences that underlie U.S. and Japanese perspectives.

Mr. Prestowitz overlooks some of the more obvious explanations for Japanese attitudes on certain policy issues. For example, he thinks that the reason Japanese consumers are willing to pay 5 to 10 times the world price for rice has to do with "overly strict land-use regulations" and the political power of farmers. What he neglects to mention is that all Japanese over the age of about 45 remember how it feels to starve. Although people discuss these memories very little, the generation currently in power is reluctant to become more dependent on food from abroad. For the next 10 or 15 years, all of our pos-



turing and arm waving about how Japan should buy more of our rice, beef, and oranges and turn farmland into condos and shopping malls can be expected to have little effect.

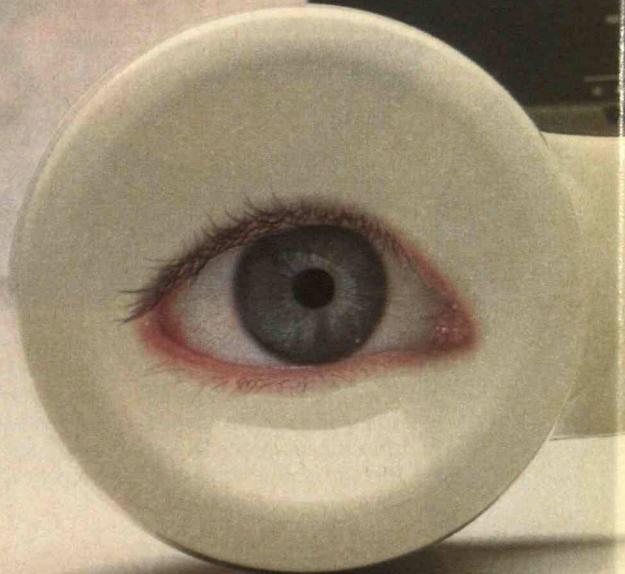
The suggestion that there should be some sort of "affirmative action" plan in Japan to encourage foreign takeovers of Japanese companies is simply laughable.

The reality is that in private, the Japanese unanimously believe we Americans have been complete fools for failing to protect our key domestic markets and industries.

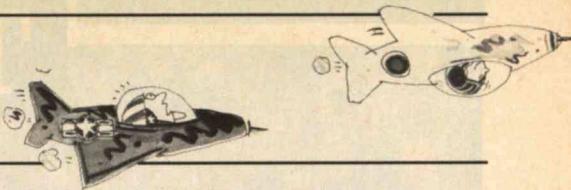
Mr. Prestowitz also fails to see how Japan uses its "inefficient" consumer-goods distribution system—with its "mom and pop" shops—to deal with a wide variety of socioeconomic needs. For instance, the system lets families meet their obligation to provide useful employment for the ne'er-do-well brother-in-law who in this country would likely be supported at far greater expense by taxpayers. In fact, it is pointless to compare the efficacy of the Japanese and American systems, since the Japanese system, depending as it does on a high degree of cultural homogeneity, could never exist here. Once we consider the overall economic efficiency of the two approaches, it is not at all clear that the U.S. system works better.

If we continue to preach to the Japanese about how they should change their internal systems to suit our liking, they will continue to smile politely and find ways

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LETTERS



to outmaneuver us. We will fare much better if we accept the reality that U.S. and Japanese economic systems are irreconcilably different and negotiate on the broadest possible "bottom line" basis, keeping the three key issues of trade balance, access to capital markets, and defense-cost sharing firmly coupled together.

D. DAVID COOK
Redondo Beach, Calif.

Prestowitz makes a big mistake when he identifies U.S. economic ideology with "Western economic ideology." I predict that if the European communities are successful in their plans to unify Europe by 1992, they will adopt precisely the same policies to nurture, expand, and protect their key industries as the Japanese. I hope that by then U.S. policymakers understand the nature of the economic competition between powerful nations. Our ethnocentric establishment has been asleep for too long.

C.A. DESOER
Berkeley, Calif.

In dealing with Japan, the United States is handicapped by several factors Clyde Prestowitz does not mention. For example, Japanese who come to work in America know English well, but our executives are rarely knowledgeable in Japanese. And Japan produces more graduate engineers than we do, though we have twice the population.

It is also worth noting that Japan has plenty of company in agricultural protectionism. In Japan rice costs much more than the world price, and in the United States sugar costs much more than the world price. The pricing policies in both countries turn on provincial perspectives. Moreover, Japan has good reason to protect its agriculture. In 1973, the country purchased 98 percent of its soybeans from us, after we had promoted soybean production and marketing. However, after a considerable price rise, we embargoed soybean sales to Japan—with little consultation and in the face of vigorous protests. The embargo was lifted after a few months, but what guarantee can we give

never to use food in a political way?

Finally, as Prestowitz points out, Japan is not the only country that needs to make significant policy changes. In the United States, unlike Western Europe and Japan, landowners are relatively free to do as they wish with their property—and the result is loss of upland soil, siltation of reservoirs, and an unaccounted burden to future generations. Weak restrictions have meant that prime agricultural land has been used for other purposes. Will our descendants need this land for farming? Does our urban sprawl augur well for a time within 40 years when petroleum products will be much more expensive?

EDWIN KESSLER
Norman, Okla.

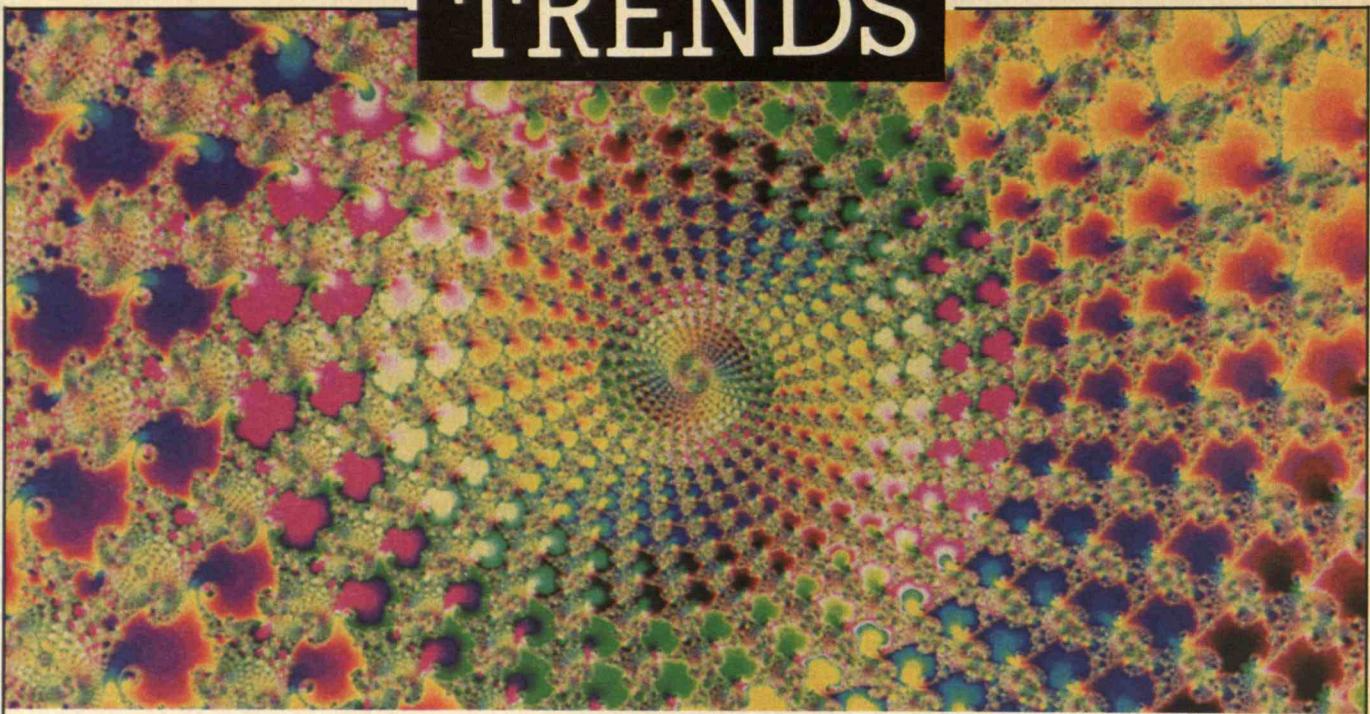
There's no moral imperative to support our choice of free trade and competition over Japan's regulated economy. It's both illogical and futile to criticize the Japanese for not playing by our rules. So long as we continue to support Japan's policies by *Continued on page 20*



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Dancing to Fractal Time

In the 1950s, Benoit Mandelbrot began looking for order in what seemed to be disorderly but recurrent phenomena—noise in electrical transmissions, fluctuating commodity prices, the rise and fall of the Nile. A scholarly nomad working outside the boundaries of traditional academic disciplines, he found his answer in 1975.

Mandelbrot discovered a unifying principle of nature and a mathematical means to express it. He coined the term fractals—from the Latin “to break”—to describe a class of “self-similar, scale-invariant” shapes. The twig, which looks like a branch, which looks like the tree, is self-similar, and this is a fractal. Clouds, earthquake fault lines, the binding sites of proteins, and the pores in charcoal are all fractals.

At first, no one paid much attention. Without computer graphics, fractals were simply a great intellectual leap. But working with programmers in the late 1970s, Mandelbrot began to produce images of

his mathematical patterns. Their beauty hooked the public as well as the scientific community.

Since the 1982 publication of Mandelbrot's book, *The Fractal Geometry of Nature*, scientists have discovered fractals in discipline after discipline. Scientists, in particular physicists and materials scientists, want to understand what accounts for this fractal abundance. By understanding how fractals grow, researchers might fashion materials with better physical, mechanical, electrical, and optical qualities.

Mandelbrot was not the first to unearth these shapes. Between 1875 and 1925, some mathematicians studied forms so contorted that colleagues labeled them “pathological” and “monsters.”

“The realization that these complicated things were not pathological but normal was the major contribution of fractals to my field,” says Cornell mathematician John Hubbard. He works with dynamical systems—systems that evolve over time. “Every-

one expects any realistic dynamical system to give rise to fractals.” In other words, “fractal geometry” can describe these seemingly chaotic systems.

In everyday geometry, a line fills one dimension, a square two dimensions, and a cube three dimensions. But fractals have fractional dimensions. The fractal with 2.5 dimensions fills more space than a two-dimensional square and less than a three-dimensional cube. Du Pont physicist Paul Meakin believes this esoteric geometry would be key to applying Mandelbrot's concept to materials science. “If you were restricted to measuring one thing, you would want to measure fractal dimension,” he says.

Mixing Oil and Water

The fractal dimension carries clues to physical properties. A material with a fractal dimension less than two will become transparent as it grows; with a fractal dimension greater than two, it will be-

Not only are fractal patterns beautiful but they are proving useful in materials science, oil recovery, and medicine.

come opaque. Applying this to cracks in silicon nitride, a high-performance ceramic, Northwestern University ceramic engineer Katherine Faber found that higher fractal dimensions mean tougher materials.

Meakin applies fractals to studying how materials grow in rapid, “non-equilibrium” conditions. Growing a crystal slowly produces a more or less perfect structure. “If you grow it rapidly, you get branching, and eventually a chaotic, dendritic structure that is often a fractal,” he says. Non-equilibrium growth is the rule rather than the exception in nature.

Researchers have come up with two simple computer models that describe chaotic growth. In the “diffusion limited aggregation” model, developed by Leonard Sander at the University of Michigan and Thomas Witten at Exxon

Revolutionary computer architectures have the potential to achieve massive parallel processing capabilities beyond that of the fastest conventional supercomputers. Under development by Hughes Aircraft Company for the U.S. Army Strategic Defense Command, these new architectures are designed to mimic the brain's vastly complex neurobiological structure. Using this technology, a new generation of computers may provide the solution for real-time processing problems like automatic target recognition, weapons allocation, automatic speaker identification and multi-sensor data fusion.

Voice and data communication to and from vehicles virtually anywhere in North America will soon be possible through a satellite system under development by Hughes and seven other companies that form the American Mobile Satellite Consortium. The system would allow drivers unrestricted contact with any telephone anywhere in the world. Current cellular telephone systems require drivers to be within range of special two-way radio towers, leaving about 15 percent of the United States population without service. Initial customers for the new system will be trucking companies, fire fighters, search and rescue teams, and personnel working in remote areas. The service will also be available to aviators and mariners.

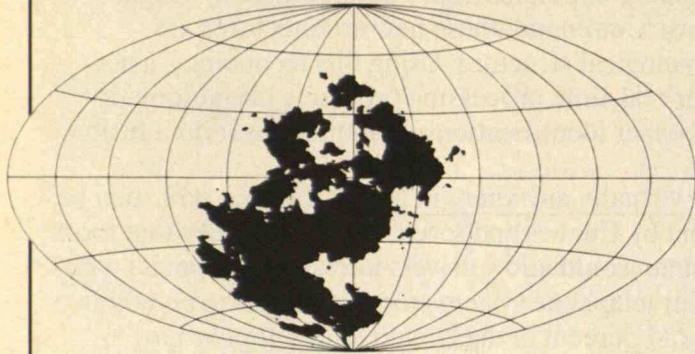
A new superprojector provides large-screen display of computer data in full color. Designated Model 1000, the projector is designed for applications where real-time computer information must be viewed by large numbers of people. High-intensity xenon arc lamps, combined with the Hughes-developed liquid crystal light valve, generate a display with resolution in excess of 1,000 TV lines. Data is seen crisply and clearly, through front or rear projection, in normal room light. The superprojector is compatible with virtually all currently available computer sources and is derived from sophisticated color projection systems developed by Hughes for military command and control centers.

Using a special space-borne sensor's data, meteorologists are able to measure wind speed at the ocean's surface and the extent and thickness of ice for ship routing. The Hughes-built imaging sensor, designated SSMI, is also designed to measure soil moisture content, which may be used to predict potential flooding. Knowing the water content trapped in mountain snow packs could also lead to better water management and help control flood damage during ice thaws by permitting early precautions to be taken. SSMI, which uses microwave energy emitted by the earth and atmosphere to record this information, is flying aboard a U.S. Air Force weather satellite.

Engineers and scientists are eligible for approximately 100 Hughes Fellowships awarded for the pursuit of Master's and doctoral studies in Engineering and Science. All Fellows work full-time at Hughes during the summer, with Work-Study Fellows working part-time during the academic year and Full-Study Fellows attending classes full-time. Fellows receive full academic expenses plus stipends for studies at approved universities. Additionally, Hughes offers a two-year, entry-level rotation program that enables qualified BS and MS graduates to diversify their engineering experience. For more information contact the Hughes Corporate Fellowship Office, Dept. S2, C1/B168, P.O. Box 45066, Los Angeles, CA 90045-0066. U.S. citizenship may be required. Equal Opportunity Employer.

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The coast of Earth's ancient supercontinent may have had a fractal dimension of 1.5. Today's coasts have a fractal dimension of 1.2.

Research and Engineering, growth occurs as particles diffuse, randomly collide, and stick together. In Meakin's "cluster-cluster aggregation" model, small clusters combine to form larger ones, which in turn form still larger ones.

The diffusion limited aggregation model is helping oil companies recover oil from almost-empty wells. To get the last bit of oil out, water is pumped into the ground; since oil and water don't mix, the oil tends to rise to the top. However, the boundary between the liquids often breaks into fractal-shaped fingers, so water pumped into the ground gets pumped right back up. Researchers have used fractals to suggest one way to stabilize the displacement process: by trial and error, they found that a polymer could be added to restrict the mixing and create a less fractal interface between the two liquids.

The most practical application of fractals may come in medicine. Ary Goldberger's colleagues were intrigued when he found neural networks, the bile-duct system, the placenta, the lung's bronchial tree, the kidney's urine-collecting tubes, the bowel's

lining, the brain's folds, and the blood vessels leading to the heart to be fractals.

A cardiologist at Boston's Beth Israel Hospital, Goldberger went further and asked, "If the structure of physiological systems is fractal, then why not their function?" He looked at sudden cardiac arrests, the leading killer of U.S. men aged 20 to 60. Most physicians had thought that heart rhythms become more chaotic as a person ages. After analyzing heartbeats in 16 cardiac patients, Goldberger suggests the opposite: the ailing heart is less chaotic.

"A healthy system needs to respond to an unpredictable environment," says Goldberger. He found that normal heart fluctuations can be plotted and a fractal dimension calculated. "A healthy physiological system dances to a fractal time."

Goldberger says a person's fractal dimension gradually declines. He proposes that this might yield a quantitative way to measure "the difference between someone's physiological age and their chronological age." Just as doctors keep track of your cholesterol count, in the future they may take your fractal. ■

*JEANNE McDERMOTT is the author of *The Killing Winds: The Menace of Biological Warfare*.*

What Is Clean Air?

As Christopher Columbus approached his first landfall in the Americas, he recorded that "the air is soft . . . and it is a pleasure to be in it, so fragrant it is." As pollution has grown, scientists have sought to determine what made up that soft air. Unfortunately, precision instruments for analyzing the intensity and movement of clouds, aerosols, and trace gases have arrived only recently, when very little unspoiled air remains to study.

With greenhouse gases such as methane and nitrous oxide increasing, governments and international bodies need such data to set standards for controlling pollution. Of particular interest is the troposphere's boundary layer, a scene of great activity that reaches to the upper level of the clouds. The troposphere as a whole, which rises from the treetops to a height of about 11 miles, determines the weather and provides early warnings of global climate change.

Pure air does survive in the Amazon River Basin of Brazil, the world's largest pristine ecosystem. Over the last three years, 100 Brazilian and 60 U.S. field scientists—plus many more in data analysis, meteorological support, logistics, and planning—have conducted an unprecedented study of this atmospheric wilderness. Sponsored by NASA and its Brazilian counterpart, the Instituto Nacional de Pesquisas Espaciais (the National Institute of Space Research), the Amazon Boundary Layer Experiment (ABLE) is helping to reveal how both natural and human influences affect the world's

atmosphere. Robert McNeal, program manager for tropospheric chemistry in NASA's Office of Space Science, says that when ABLE concludes in several years, the data "will provide a very good baseline on atmospheric chemistry."

NASA's involvement has been critical. It is one of the few organizations that has research aircraft equipped with state-of-the-art instruments for making large-scale, on-site measurements of the atmosphere. While ABLE investigators have gathered data with everything from floating barges to tethered balloons, the focal point has been a Lockheed Electra aircraft carrying instruments developed at NASA's Langley Research Center in Virginia and other government and university laboratories.

The impetus for ABLE came from a 1981 shuttle experiment to measure air pollution from space. According to Robert Harris of Langley, data from the shuttle showed a surprising concentration of carbon monoxide off the South American coast. Over the supposedly unspoiled Amazon Basin, the experiment detected what seemed to be signs of industrial pollution.

Biomass Burn-Off

ABLE scientists found the explanation by comparing dry-season and wet-season measurements. The source of the pollution lay south of the Amazon, and it was neither industrial nor natural. Each year, ranchers and farmers in Brazil's savannas and forests burn vegetation off their land on a massive scale. As many as 7,000 fires were burning during the peak of the 1985



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U.S. and Brazilian researchers use this portable laboratory in the Amazon rain forest to study the atmosphere.



dry season, covering millions of square miles with smoke and haze.

The project yielded first-hand measurements of the burn-off's dramatic effects on a pure environment, including data on the chemical composition and distribution of the smoke. During the wet season, the carbon-monoxide concentration in the Amazon Basin ranged from 75 to 95 parts per billion (ppb), significantly better than the average of 500 ppb in rural America. During the dry season—July to October—the number hit levels previously recorded only in industrial regions. The average concentration in those months was 175 ppb, but at times it peaked at 800 ppb.

Although 70 percent of global biomass burning takes place in the tropics, its impact extends much further. The smoke plumes undergo photochemical changes similar to those that create industrial smog, and because biomass burning is widely practiced, it contributes to global and regional increases in atmospheric carbon, sulfur, and nitrogen compounds.

The international team examined a number of other components of the atmospheric chemistry over the Amazon Basin. For example, the scientists discovered that

rain there can be as acidic as it is in the United States. Some vegetation actually emits weak acids directly into the air, and ABLE revealed that another source is isoprene, a hydrocarbon that plants release during the day. Until trees absorb this gas at night, it circulates beneath the clouds, and sunlight transforms it into various acids. Nevertheless, Harriss explains, these natural acids are much less corrosive than stronger, industrially produced acids, which destroy forests and lakes.

The bulk of ABLE data, released this year, was collected in the Amazon in the 1985 dry season and the 1987 wet season. However, the venture is a continuing one. During the summer of 1988, the A in ABLE stood for arctic as another team spent six weeks in Alaska's clean environment. Future ABLE plans include visits to remote areas of Canada.

ABLE is "an example of the international effort required to preserve the earth and its climate," says McNeal. Regulators can act more confidently, using up-to-date knowledge of what the New World's air might have been when Columbus enjoyed it. ■

SUSAN A. MOTLEY is a freelance writer specializing in environmental issues.

Micro-Machines

The machinery being made at the University of California at Berkeley's Sensor and Actuator Center appears ordinary. Gears. Springs. Calipers. Turbines. Then you realize you are looking at it under a microscope. The spring is two microns wide, about 1/37 the width of a human hair.

Equally strange, the micro-parts are made of silicon compounds, not metal. And the "forging" process relies on the same crystal growth, photographic reduction, and etching techniques that create miniature computer chips.

In June 1988, the Berkeley group beat an MIT team in a race to make the first working micromotor—in this case, a turbine driven by static electricity. The size of the turbine is between 60 and 120 microns—about a hair and a half.

Of the factors likely to put the ifs and maybes of micro-machine research to rest, profit motives may be first. The potential commercial applications have brought the California lab backing from 10 U.S. corporations—including General Motors, Ford, Honeywell, and Texas Instruments—in addition to funding from the Department of Defense.

George Hazelrigg, the National Science Foundation's deputy director for electrical, communication, and systems engineering, suggests that a micromotor would cost no more than a tenth of a cent. If the experience with computer chips is a guide, that cost could fall to a thousandth of a cent as manufacturing is refined. The cheapness of the machines means that many surprising

applications might emerge.

For example, Hazelrigg imagines a power saw minute enough to cut away the scar tissue that diabetes and other diseases leave in the retina. Sound waves, electrostatic charges, or some other form of energy would power the tiny engines, he says. As he asks, "It is all very Jules Verne, right?"

Kaigham Gabriel of Bell Laboratories likens the situation to that of microprocessors, the integrated circuits that are the core of computers. "I doubt that anyone could have predicted when they first appeared that microprocessors would be used in ovens and shoes," says Gabriel. With William Trimmer and MIT researcher Mehran Mehregany, he has developed a turbine whose 110-micron-long blades spin at 24,000 revolutions per second—faster than many jet-engine turbines.

Richard Muller, co-director of the Berkeley center, predicts that microparts will find their first applications in partnership with computer chips. Microprocessors would activate the tiny machines. "Today's microprocessors provide silicon 'brain power.' The coming generation will combine these with silicon 'muscle'—with silicon eyes, noses, and ears at the same scale."

Since computer chips and micromachines are made the same way, it may even be possible to create the entire computer-machine system—chips, sensors, motors—in a single process. Tiny computer-designed machine patterns are shrunk photographically and transferred to a silicon compound. Over two days, the silicon that

won't be part of the lilliputian device is etched away.

This forging process could change how engineers think about perfecting machines. Since the whole micromachine is "grown" at once, fine-tuning it the traditional way—part by part—might not be appropriate. "If something doesn't work, you have to make the whole thing over again," Gabriel says.

Closed-Heart Surgeons

Before companies can market hair-sized tools, numerous problems remain. Muller points out that researchers must discover a great deal more about silicon's mechanical properties, such as its

elasticity and its ability to conduct heat and resist wear. Even at this stage, silicon is clearly quite a sturdy substance. "The gears and springs have strength comparable to the best steel alloys," says Muller. It is also extremely heat-resistant, melting at about 1,400°C.

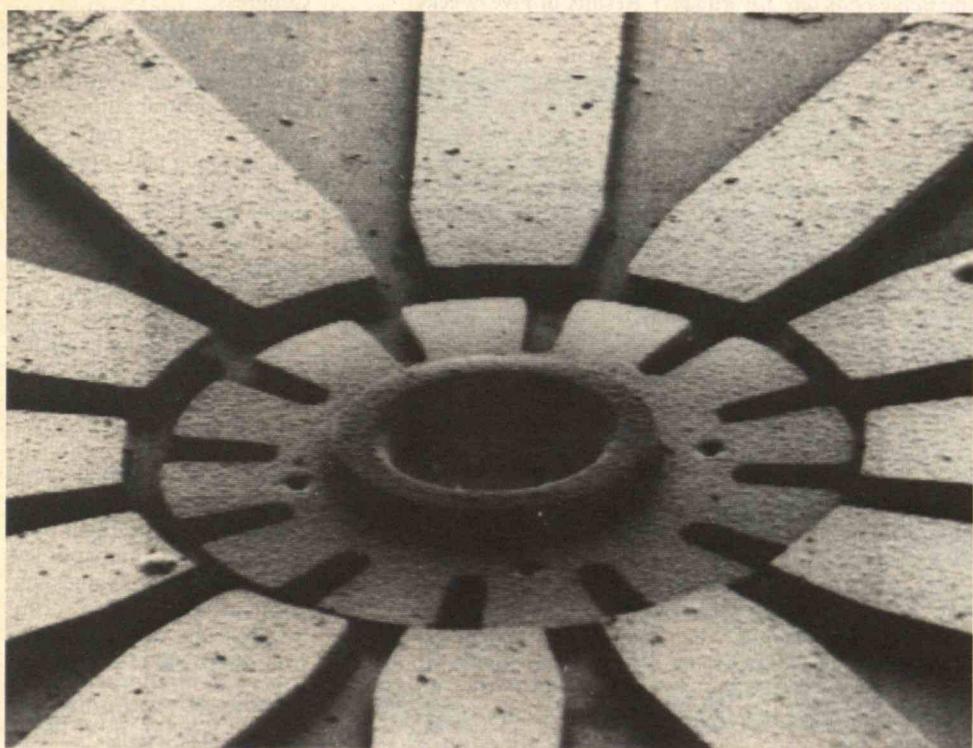
One problem results from the manufacturing process: the current microparts are essentially two-dimensional. Micron-level engineers worry that the machines won't withstand the pushes, twists, and pulls of operation. They also fear the physical encounters in a world where bacteria and protozoa are normal-sized. Hazelrigg points out that molecules and atoms in air may act like a rain of marbles in microworld. And molecular-level magnetic interactions could create a whole new class of problems.

West German researchers,

led by Werner Ehrfeld at the Karlsruhe Nuclear Research Center (*Kernforschungszentrum*), have recently found a possible way to add the third dimension. Using an x-ray etching process, they have made micron-wide etchings in material 1,000 microns thick. With that thickness, says Gabriel, the process could lead to a miniature tool-and-die industry, with some micro-mechanisms grown inside molds.

Based on such progress, Gabriel predicts that micro-products will be marketed within five years. Muller agrees: "I don't see any brick walls facing us." He hopes to be moving microjoints and gears electrically within a year or two. ■

STEPHEN STRAUSS, a regular contributor to Trends, is a science reporter for the Globe and Mail in Toronto.



Lab for the Environment

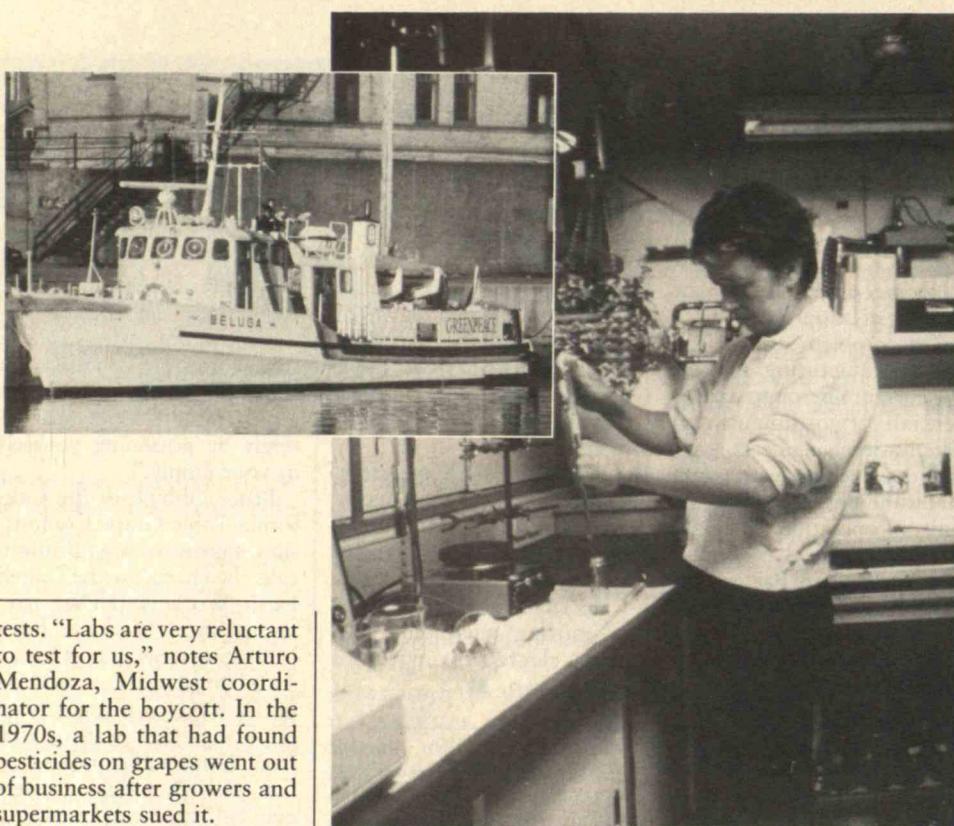
One-third of all pesticides are known to cause cancer," proclaims the flyer promoting a boycott of California table grapes, "and some of them won't even wash off under your kitchen tap... You could unwittingly be poisoning yourself or your family."

Bruce Obbink of the California Table Grape Commission, a growers' organization, calls the charge by the United Farm Workers (UFW) irresponsible. "We have been producing table grapes for an awful lot of years... and we don't have any records of anybody ever getting sick from eating table grapes."

If the UFW is right, growers are selling contaminated food. If Obbink is right, the UFW is engaged in a scare campaign. It should be simple to settle the question—but nothing is simple when the issue is a political hot potato. In fact, to get an answer, the UFW is spending about \$300,000 to build its own chemical-testing facility.

The farmworkers union is not alone in taking such a step. For a variety of reasons, public-interest groups are starting research labs. Steven Lester, science director for the Virginia-based Citizen's Clearinghouse on Hazardous Waste, thinks one reason is that many labs refuse certain jobs. This is especially true, he says, "if they're going to find themselves banging heads with the Environmental Protection Agency (EPA) or with some of the companies they're doing work with."

In fact, the UFW is building its facility because it can't find a lab to conduct independent



tests. "Labs are very reluctant to test for us," notes Arturo Mendoza, Midwest coordinator for the boycott. In the 1970s, a lab that had found pesticides on grapes went out of business after growers and supermarkets sued it.

Obbink replies that the lab had reported a banned pesticide on one sample, but no other grapes from the same farm had any pesticide residue. "Either the grapes were tampered with or the lab used faulty procedures," Obbink concludes. He adds that the grower went out of business, too.

Another organization with its own testing facility is the environmental group Greenpeace, which has converted an old fireboat into a floating laboratory. Outfitted with a gas chromatograph and a mass spectrometer—two basic tools of chemical analysis—the *Beluga* toured the Great Lakes in 1988 and then steamed down the Mississippi River.

It wasn't hard for Greenpeace to find cooperative laboratories, says John Buschek, a chemist for the group. "Most agreed to do the work," he reports. However,

the *Beluga* has one advantage over commercial labs—it attracts better publicity for Greenpeace's anti-pollution campaigns.

But organizations like Greenpeace recognize that they could run into trouble if the scientific community refuses to accept data they generate. "We have a problem," acknowledges Buschek. "People that don't want to believe us are not going to believe us." Thus, Greenpeace hires commercial labs to back up the *Beluga's* research.

"We're independently owned," says Catherine Mocniak of Advanced Environmental Systems, one of two labs that Greenpeace hires. "We have no allegiance to any government or industry organization." Even so, when Greenpeace approached her firm, "We discussed it with some of our very large industrial customers."

Results in Five Weeks

In many cases, speed is the motive. In Cass Lake, Minn., the Chippewa are building a chemical lab to test the Keweenaw Bay, the water source for their reservation. The bay is threatened by mining deposits and municipal sewage, says Howard Reynolds, environmental coordinator for a Chippewa group in Michigan's upper peninsula. He became convinced of the need for a tribally owned lab after EPA said it had no funds for the tests.

Michael Swan, a Chippewa aquatic biologist, notes that his tribe currently ships water samples to Texas and New Mexico and waits months for the results. "If we have our own lab, we can get results back in a couple of days." Supported by the Bureau of Indian Affairs, the lab will serve six tribes on 29 reser-

Greenpeace thinks its research lab aboard the *Beluga* helps publicize anti-pollution campaigns.

vations in the northern Great Lakes area.

Speed is also crucial to the Audubon Society's acid-rain campaign. Government studies sometimes withhold data for years, says Audubon vice president Robert San George, but "the average citizen has trouble getting worked up about rain that fell a year and a half ago."

Audubon involves 225 society members from all 50 states in a "citizen science" program that gets information out within five weeks. Volunteers collect rain samples, test their acidity levels, and report the results to Audubon headquarters, which releases a monthly national map of acid-rain levels. The information is used to lobby Congress.

While environmentalists say their labs provide unbiased scientific information, finding a neutral authority to answer complex public-policy questions may prove difficult in the end. But Lester thinks that neutrality may be too much to expect in controversies about pollution and chemical contamination. For example, a laboratory might follow instructions explicitly when judging a water sample—and report no contaminants if the result is negative. But what if the researchers know other tests that could show evidence of pollution? Should they carry them out?

"It gets into an area of less science and more values and politics," says Lester. "Ultimately, you can't get away from that." ■

ROGER KERSON is a Chicago-based free-lance writer.

involves the hippocampus, brain regions involved in memory and learning, and the neocortex, the outer layer of the brain.

Mind Meets Brain

Scientists in two of psychology's major branches traditionally have had little to say to each other. Cognitive psychologists focus on processes like seeing and thinking without caring much about how the brain carries them out. Neuroscientists study the activity of brain cells but often ignore how this mediates perception and thought.

Because a full understanding of the human brain would bridge function and structure, many researchers welcome signs that the two approaches are beginning to dovetail. Steps in this direction are coming to be known under the general rubric of cognitive neuroscience.

Some researchers in this hybrid field are taking advantage of positron emission tomography (PET), a diagnostic tool that doctors have employed for several years to produce images of patients' brains. Cognitive neuroscientists apply PET to psychological questions. These researchers use it to monitor and map brain activity while a person is performing particular tasks.

University of Oregon psychologist Michael Posner and colleagues recently exploited PET technology to answer a long-standing question. At issue was whether the brain must translate written words into sound patterns—a "phonological code"—to understand them.

As expected, PET data showed that during a task dealing only with the sound

of words—judging whether two words rhyme, for example—activity increases in a part of the brain that is responsible for hearing. But this same area, which is thought to be the seat of the phonological code, is quiet during a task based strictly on the meaning of words—for example, saying "eat" after reading "cake." Thus, no phonological coding occurs. The conclusion that Posner has drawn is that written words can be understood without translating them into sounds.

Posner is also investigating the assortment of psychological processes that help people cope with the torrent of information their senses provide. He has developed a theory to explain "visual attention"—how people focus on relevant visual information while disregarding other data.

In the manner of traditional cognitive psychology, Posner looks at the coordination of a few simple mental operations. He points out that three distinct operations occur when people move the focus of their attention. First, the attention disengages from one location. Then it moves, and finally it engages at a new spot.

Drawing on neuroscience, Posner goes further. He believes he has found where the brain handles each operation. "What the brain has done is localize different elementary operations in different neural tissue," he says. The "disengage" function seems to reside in the parietal lobes: patients with damage there respond slowly to objects that appear away from the focal point of attention but react normally to those that appear near it. By observing the results of damage to other brain areas, Posner theorizes that the "move" function occurs largely in the midbrain and

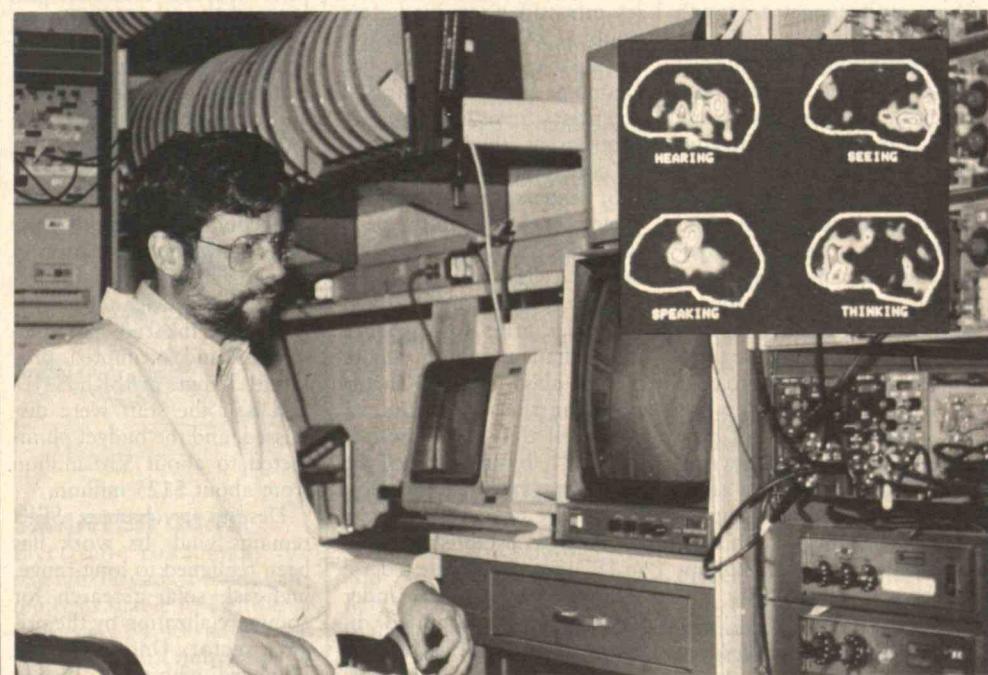
"engage" in the thalamus.

Monkey See, Monkey Think

While Posner examines the entire brain, Robert Desimone, a neurophysiologist at the National Institute of Mental Health, is studying what happens in individual neurons during visual attention. His investigations, which involve training monkeys to perform sophisticated tasks, are part of a trend toward applying brain-science techniques to increasingly complex mental phenomena.

Desimone thinks that many of his findings would have been impossible without directly observing brain cells. So while monkeys can take nine months to learn what a person could learn in 15 sec-

Inset: Some researchers use images of the brain to reveal which parts are active when a particular task is performed.



Neurophysiologist Robert Desimone is studying what happens in individual neurons during visual attention.

onds, researchers have no alternative to using the research animals.

In one study, Desimone trained monkeys to decide whether two colors match. He found that neurons in a part of the brain that processes visual information respond more strongly and selectively if the monkey expects the colors to be similar. "Until we did this experiment," Desimone notes, "my thinking was that attention strictly served to block processing" of extraneous information. Instead, attention makes a neuron's response more intense when extra discrimination is needed. These findings show that even basic sensory processing is affected by an animal's mental state.

Such findings notwithstanding, the merger of cognitive psychology and neuroscience into a single field is not assured. Skeptics contend that for some time the main discoveries will likely occur within psychology's traditional branches. "You can't expect a growth industry at the margins," says MIT cognitive psychologist Mary Potter, because the laws of brain science have only loose connections to the laws of mind.

Still, cognitive neuroscience is producing results, and a growing number of researchers are appreciating the promise of interdisciplinary work. It's now possible, says Desimone, "to bring the techniques of brain science to bear on what we consider the really big questions" of how thought and perception work. That's a strong claim, since while few doubt that neurons are the medium of cognition, many despair of ever explaining the connection. ■

JOHN RUBIN is a writer living in Berkeley, Calif.



Developed at the Solar Energy Research Institute, these oils could help convert sawdust into industrial adhesives.

1981, SERI's 438 employees provide information crucial to solar industries.

Photovoltaics, which converts sunlight directly into electricity, accounts for 40 percent of the institute's budget and is one of SERI's most promising research areas. "It boggles the mind, the advances that have taken place in the area of photovoltaics in the past year," says program manager Tom Surek.

According to Surek, SERI projects have been setting new records for efficiency. Some advanced materials convert 30 percent of the sun's energy into electricity, which, he says, "was a goal we've been trying to reach." As these technologies are refined for mass production, he expects a "threefold decrease in cost, which will make photovoltaics competitive" when electricity demand is high.

Innovation for Industry

SERI's other programs are paying dividends as well. Discussions are under way with major glass manufacturers who want to take advantage of a window design from SERI's solar-heat division. By sealing a vacuum between two panes of glass, researchers have produced windows with five times the insulation of standard double-glazing.

In addition, Pyrotech Corp. has adapted the solar-fuel program's process of chemically converting sawdust and bark into gasoline and other high-grade fuels. Adhesives companies, such as Borden, Gaylord, and Boise Cascade, are studying resins SERI has produced from these same waste materials. Such compounds could be made for half the cost of regular adhesives—and save energy.

SERI-developed technolo-

Solar Studies

For the Solar Energy Research Institute (SERI), a top priority is U.S. technological leadership, and its innovations are yielding improved products and industrial processes. Nevertheless, some observers think SERI was more effective in its early years, when it was a world leader in research on efficiency and renewable energy.

Though its budget was slashed in the early 1980s and its mission narrowed, few doubt SERI's value as a center for solar-energy studies. For example, SERI and Harvard scientists have developed a transparent, thin-film electrical contact that contributes to U.S. leadership in high-efficiency solar cells. In the past, wire-like contacts on the surface of cells had reduced efficiency because they blocked light. U.S. firms now produce more than a million square feet of glass annually incorporating the new contacts. And self-defrosting windshields, a by-product of the technology, melt a tenth of an inch of ice in two minutes.

Congress established SERI in 1974 to consolidate federal solar-energy research. Under Denis Hayes, appointed director in 1979, SERI became a mecca for energy analysts,

who converged on its Golden, Colo., labs to help build a safe, sustainable, economical energy future. The originator of Earth Day, Hayes defined solar research to include "the efficient use of renewable energy." SERI established ties with regional and international solar centers, evaluated alternative vehicles, and conducted solar-energy workshops. According to Hayes, early SERI analysts "believed they were on the vanguard of saving the world from the collapse of the oil economy."

In 1979 Congress asked SERI to analyze the potential contribution of conservation and renewable sources to the nation's energy future. After 18 months of research, SERI reported that the U.S. economy could grow rapidly while reducing energy consumption 25 percent. However, the advent of the Reagan administration left the study unimplemented and prompted profound changes at SERI. Hayes and half the staff were dismissed, and the budget plummeted to about \$30 million from about \$125 million.

Despite its changes, SERI remains vital. Its work has been realigned to long-range, high-risk solar research for commercialization by the private sector. Under Harold Hubbard, who took office in

gies have also given birth to more than a dozen companies. Industrial Solar Technology, Inc., manufactures solar-thermal power plants that use sunlight to produce hot water and electricity for commercial buildings. Syngas Corp. of Colorado is using SERI technology in its commercial gasifiers, which make synthetic gas from wood waste, yielding both electricity and fuel for industrial applications. Syngas is incorporating wood gasifiers into a 10-megawatt plant it is building in New Jersey to produce power for 300 homes.

Perhaps most indicative of SERI's approach is its "cost-shared" program. Each of four companies, selected through competitive bids, fund and conduct research jointly with the institute. The firms have a stake in the technology, fulfilling SERI's mission. The contributing industries receive the patent rights to the technology. Hubbard believes that if federal laboratories are to assist industry "with the goal of technological competitiveness," such programs could serve as "a model."

Despite SERI's progress—and despite Hubbard's many attempts to increase R&D funding and develop an awareness of solar energy's potential—the budget remains less than half what it was in the 1970s, limiting SERI's effectiveness and curtailing the development of solar energy. According to Hubbard, "Emerging renewable technologies are clearly doable and can be made cost-effective." To accelerate the process, however, "SERI will require increased funding."

SUSAN HASSOL is associate editor of IRT: Issues Review and Tracking, a strategic newsletter on energy issues. TED FLANIGAN is its editor.

MINI-TRENDS

SMART CARS

A vision of smart cars driving on roads outfitted to handle them sounds like science fiction, but Robert Ervin, acting director of the University of Michigan Transportation Research Institute, thinks the technology exists today. The roadblock is getting the requisite equipment into highways. "What we need now is not technological wizardry, but coherent and thoughtful planning by manufacturers, road builders, and state and federal government agencies," he says.

Some vehicle-based technologies are already finding uses. Trucking companies monitor their fleets with automatic vehicle-location systems, and police, fire, and ambulance dispatchers employ the same systems. Radar-guided systems to detect and avoid obstacles could be marketed soon, as could communications devices that provide real-time traffic information. And manufacturers are exploring smart cruise controls that sense vehicles ahead and maintain a safe clearance.



SMARTER CARS

Electronic road maps are passing the gadget stage. Currently available to California drivers is a \$1,400 navigation system that not only tells you where you are but the best route to your destination.

An arrow marks your car's position on a green street grid on a 4.5-inch, dashboard-mounted monitor. As the car moves, the map display moves with it, rotating as the car turns to match what you see through the windshield. A simple personal computer in the trunk controls the system.

ENGINEERING EDUCATION

It is a commonplace that companies must upgrade their manufacturing technology to compete internationally. According to a National Academy of Engineering (NAE) report, career-long education to maintain the quality of intellectual resources is also indispensable.

Focus on the Future: A National Action Plan for Career-Long Education for Engineers points out that much of the knowledge gained from formal engineering education is obsolete in three to seven years. Moreover, numerous studies have documented large productivity increases from on-the-job engineering training. Motorola experienced a "30:1 payoff in revenue in the same year," says the report. AT&T combined training and computer-aided design facilities to increase the productivity of its design engineering staff fivefold over 10 years.



within muscles. This makes nerves release endorphins, the same morphine-like compounds that yield acupuncture's analgesic effects, according to *Current Comments*.

Electrical engineer Salansky has patented the device, and Pomeranz, a physiologist who is an expert on acupuncture, has been supervising clinical trials. They have completed three controlled studies in Canada on patients hospitalized for chronic pain. The subjects receive 30 minutes of electro-acupuncture a day. Four-fifths have experienced 24 hours of relief.

FOOD SHORTAGES

Drought-damaged harvests in the United States, Canada, and China will lead to the steepest drop in world grain stocks ever recorded, warns Lester Brown, president of Worldwatch Institute and former administrator of the USDA's International Agriculture Development Service. Stocks at the end of 1988 were expected to fall to 54 days of world consumption—below the 57-day level that more than doubled world grain prices in 1973.

Brown notes that grain output shot up between 1950 and 1984, "but since then its growth has slowed markedly." In part, lower grain prices are responsible. So, too, are land shortages, soil erosion, a scarcity of fresh water, and even a diminishing backlog of new farm technology.

ELECTRO-ACUPUNCTURE

University of Toronto researchers Bruce Pomeranz and Norman Salansky have developed an electronic replacement for acupuncture needles. By applying electrical pulses to the skin, the device stimulates nerve complexes

How the Japanese Manage Risk

Americans hear so much about Japan as the success story of the international economy, they sometimes forget that the Japanese have economic problems of their own. Japan has its declining industries like steel and its low-wage competitors such as South Korea and Taiwan. And in an era of fast-paced economic change—exemplified by the recent loss of advantage in international markets caused by the high yen—it also has its problems of social adjustment.

But what is so remarkable about the Japanese economy is its capacity to address such difficulties and adapt to change while remaining productive. On a recent trip to Japan, I came to the conclusion that if there is any one secret to this success, it lies in the way Japanese manufacturers manage risk.

The Hot-Potato Approach

Most large U.S. corporations try to insulate themselves from risk. They position themselves to unload unexpected costs onto others like a hot potato. Companies pass increased costs on to consumers through price rises when they can, play one subcontractor against another in search of the cheapest parts, and "whipsaw" workers in one plant against those in another to gain wage concessions.

This approach to risk may have worked well in the past—at least for stockholders—but given the new realities of the world economy, it has become a recipe for disaster. As international competition grows stronger, saddling consumers with increased costs is more difficult. And shifting economic risks onto subcontractors and workers, the groups least able to resist, certainly doesn't encourage the high levels of trust that more and more observers see as necessary to improve productivity and increase innovation.

In fact, the tendency to hand risk off to others is the main reason that—to put it bluntly—American workers generally don't trust their bosses. Without that trust, the sharing of information, the commitment to quality, and all the rest that goes into the idea of industrial "teamwork" just isn't going to happen in the United States.



Where U.S. companies avoid risk, their Japanese counterparts share it.

Finally, because U.S. companies are so averse to risk, they tend to shortchange their employees—and ultimately themselves—by skimping on training. In the past decade, some businesses have made substantial investments in new workplace technologies. But these have not been matched by equivalent investments in worker training. As a result, U.S. firms have not been able to take full advantage of these technologies to increase productivity and improve quality.

Sharing Risk Instead of Avoiding It

In key sectors of their economy, the Japanese do it differently. Rather than avoid risk, they manage it by sharing the unanticipated costs of economic change. In one large steel company that I visited, production workers whose jobs were eliminated at one mill were quickly placed by management in new jobs—either elsewhere in the corporation,

or at a subcontractor's shop, or with a local government agency such as the public works authority.

The primary subcontractors of large Japanese corporations often receive a great deal of financial and technical support from the core firm. This encourages small companies to experiment and innovate because they know that the penalties for failure seldom include outright termination of the relationship. Likewise, if a risky R&D project undertaken by a subcontractor does produce a breakthrough, the gains are shared throughout the production system, not appropriated entirely by the large firm. This holds true even if, as is common, the core firm has financed much of the cost of doing the research in the first place. And everybody in the system receives a lot of training.

The result of this very different organizational philosophy—risk sharing, as opposed to risk avoidance—is to maximize the exchange of information among producers. Suppliers routinely participate in product and process design. And because information among suppliers flows relatively freely, managers at any one are free to specialize in particular products or components without having to "bet the firm."

Since the gains from any particular technological breakthrough tend to be shared by everyone involved, information produced by one business is less likely to be hoarded and is more often shared at an early stage of innovation. Regular meetings between a large firm and research personnel from its leading subcontractors encourage this process. All of this allows the leading firms to mobilize the capabilities of many companies early in the cycle of new product development. The result is higher product quality and shorter development time.

Through practices such as risk sharing and greater diffusion of information, the Japanese have succeeded in incorporating the pre-capitalist principle of "reciprocity" into what is arguably the most successful capitalist production system in the modern world. Such reciprocity makes linkages among large firms and small far tighter than in the United States, and the assumption that "we're all in this together" much stronger. This makes it easier for Japanese businesses to take advantage of the information and expertise embedded in the network of small suppliers. Ultimately, that information is the key to higher productivity and long-run economic growth. It's one Japanese lesson that American corporations would do well to learn. ■

BENNETT HARRISON IS PROFESSOR OF POLITICAL ECONOMY AND PLANNING AT MIT. HIS NEW BOOK THE GREAT U-TURN, CO-AUTHORED WITH BARRY BLUESTONE, WILL BE PUBLISHED THIS MONTH.



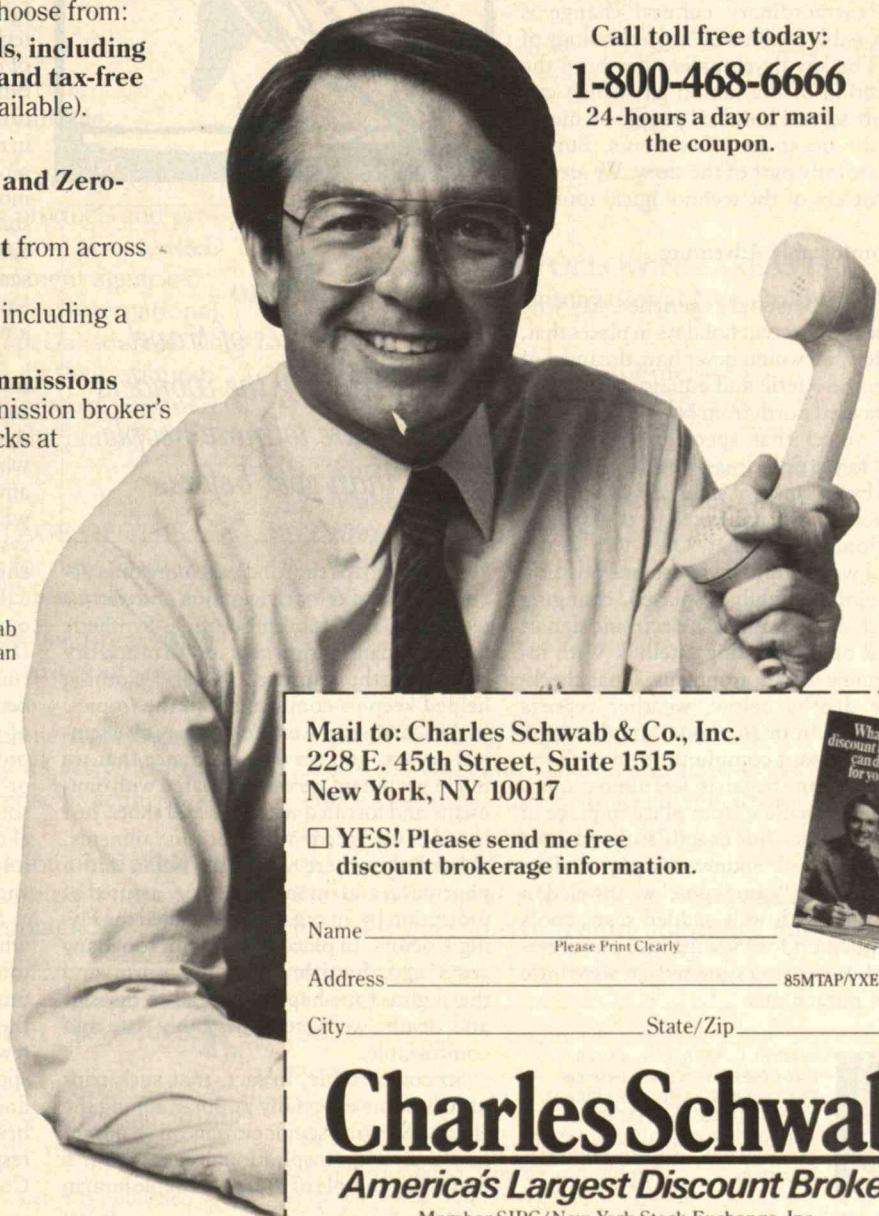
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The Technological Tourist

Exceptional Experiences for Selective Travelers!" So promises an advertisement in my college alumni magazine. Tours are scheduled to places "mysterious" (Central Asia), "enigmatic" (Borneo), "primitive" (the Amazon), "compelling" (New Guinea), "exciting" (Tanzania), and much more. It seems that Paris, Rome, and the English countryside are old hat. The exotic trip, promising adventure spiced with a touch of erudition, has become big business. Experiences once reserved for the special few are now available to anyone with the time and money to take a two-week vacation abroad.

This extraordinary cultural change is made possible by the evolving technology of travel. The key development has been the proliferation of the jumbo jet, which can transport several hundred people en masse across the ocean in a few hours. But jet planes are only part of the story. We are entering the era of the technological tourist.

The Comfortable Adventure

I speak from personal experience. My wife and I spent two recent holidays in places that, until lately, we would never have dreamed of visiting: the Arctic and equatorial Africa.

We traveled north from Norway in an "explorer" vessel that specializes in taking tourists to the polar seas. Our comfort was assured by an excellent stabilizer system, and our peace of mind enhanced by the latest in navigational equipment. On a visit to the bridge, I was enthralled to see our position on the globe digitally displayed, changing with each nautical mile, as electronic signals bounced off an orbiting satellite. With radar scanning the sea around us, sonar checking the depths below, weather reports streaming in from all about, and the ship's radio in constant communication with the coast guard, one began to feel almost snug.

In Kenya, we flew from place to place in small airplanes—not exactly futuristic but nonetheless well endowed with modern equipment. For "game runs," we traveled in Toyota vans with well-padded seats, roofs that popped up for viewing and photography, and suspension systems that were little short of miraculous.



SAMUEL C. FLORMAN, A CIVIL ENGINEER, IS THE AUTHOR OF ENGINEERING AND THE LIBERAL ARTS, THE EXISTENTIAL PLEASURES OF ENGINEERING, BLAMING TECHNOLOGY, AND THE CIVILIZED ENGINEER.



New technologies of travel are bringing the wonders of nature to more people than ever before.

On both trips the food was more than acceptable, thanks to refrigeration and various technologies of food processing. Synthetic fabrics and insulation kept us warm and dry in the north; improved "safari" clothing helped keep us comfortable in the tropics. In Africa, insects were kept at bay by chemical sprays, and on the off chance that we might get bitten, we were prepared with ointments and fortified with pills and shots. Just in case we faced more serious ailments, aboard ship there was a physician and a pharmacy, and on safari we were assured of protection by an organization called the Flying Doctors. In places where, not too many years ago, hardship was the norm and the slightest mishap could lead to disaster and death, we were remarkably safe and comfortable.

So comfortable, in fact, that such trips have become especially popular among the elderly. Meeting senior citizens on an adventure tour is an inspirational experience, a dramatic example of the indomitable human

spirit. Yet their presence in large numbers confronts one with the undeniable fact that the trip is less demanding, less dangerous, less *adventurous* than one might have supposed when dreaming about it in an armchair at home. I will never forget the thrill of going by rubber raft across an icy sea, surrounded by glaciers, a mere 600 miles from the North Pole, and then the strange feeling upon seeing an 85-year-old lady picked up bodily by one of the ship's crew and deposited by my side on the shore.

Ruined By Its Own Success?

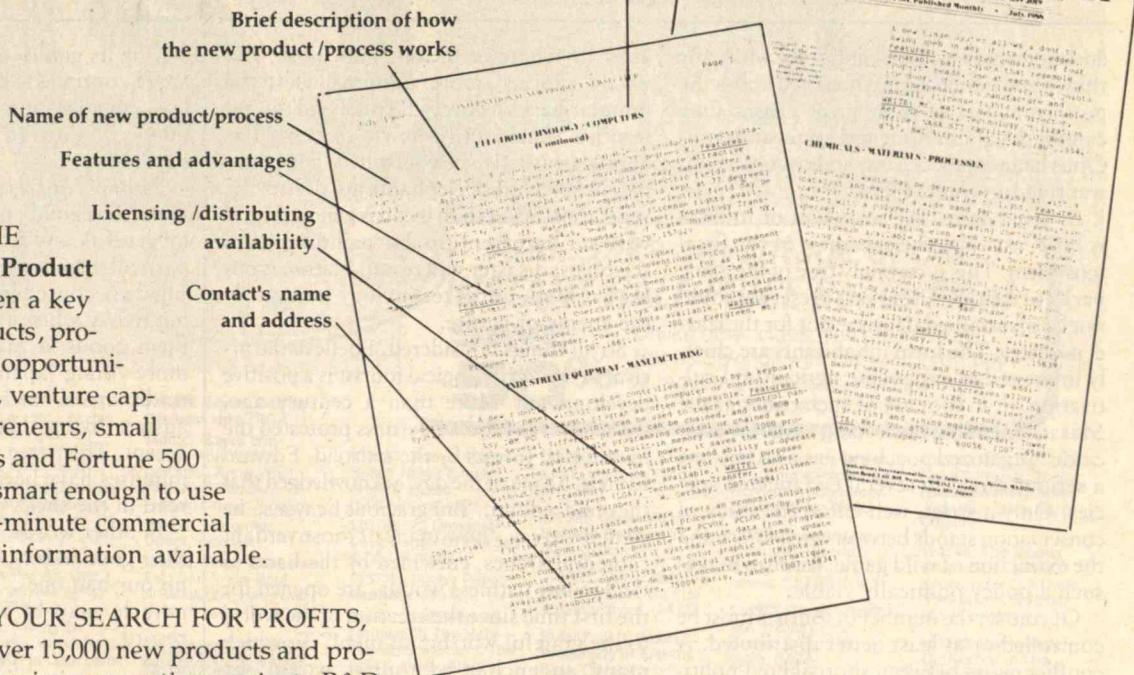
Is this development to be deplored? Has the technology of tourism reduced the quotient of excitement and romance in the world? I think not. It is an extraordinary experience to walk upon a glacier or to spy a cheetah in the tall grass, no matter how safe one may be and no matter who may be sharing the moment. And let us recognize that at least *some* element of daring is still involved: it can't be fun to become seriously ill on rough seas halfway between Spitzbergen and Iceland; and in Africa, every now and then, a tourist does get killed by a lion!

Nor need we feel sorry for true explorers, since there are still several frontiers on earth, such as the ocean depths—not to mention the "final frontier" of space. As for those who seek old-fashioned adventure, there is ample room—most of the world, in fact—where one can leave comfort and support systems behind and take one's chances with challenging climates and cultures.

If pure danger is one's fancy, then technology gives at least as much as it takes away. Daredevils who would have liked to chance running into an iceberg in the Arctic Sea, or being frozen in for the winter without hope of rescue, can try skiing down avalanche-prone slopes, accessible only by helicopter, or take up hang gliding, parachuting, or some other technological peril. And if travel to exotic-sounding places is not as good for one-upmanship as it used to be, well, snobs will not fail to find substitutes.

More troublesome is the question of whether this intrusion by large numbers of tourists into remote places will not do serious environmental damage. Again, I think the answer is no, although perhaps with a few qualifications. Many of these trips are sponsored by scientific organizations, and undertaken by people with at least an embryonic interest in the natural world. In this respect, the trips are breeding grounds for *Continued on page 20*

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environmentalists. One cannot see whales or rhinos and not become concerned about the precarious fate of these great beasts. One cannot delight in flora and fauna and wondrous landscapes, oceans, and rivers without wanting to protect them.

In some cases, the intrusion of tourists is little less than the salvation of the local biosystem. This is certainly true of the game parks of Kenya. These vast preserves could not be maintained if it were not for the travel industry. The local inhabitants are chiefly interested in expanding agricultural cultivation or, in the case of such tribes as the Masai, extending the feeding range for their cattle. Organized poaching has also become a serious threat to several endangered species. Only a strict, well-enforced policy of conservation stands between such forces and the extinction of wild game; tourism makes such a policy politically viable.

Of course, the number of tourists must be controlled or at least better distributed. A conflict exists between shortsighted politicians who want more tourist dollars immedi-

ately by whatever means, and those who would proceed more cautiously lest the popular parks be overwhelmed and the enterprise ruined by its own success. The animals must also be controlled. For example, in some areas elephants are destroying vegetation faster than it can regenerate, and without intervention by environmental scientists, disaster will result. Nature is not always kind, nor is technology necessarily the enemy of nature.

So all things considered, I believe the arrival of the technological tourist is a positive development. More than a century ago, when lovers of the wilderness protested the invasion of forests by the railroad, Edward Everett, a sage of the day, acknowledged that they had a point. "But gracious heavens," he went on to say, "how many of those verdant cathedral arches, entwined by the hand of God in our pathless woods, are opened for the first time since the creation of the world to the grateful worship of men!" To which many an enchanted tourist would say "amen." ■

buying its goods—and so long as the Japanese continue to tolerate high prices and low consumption at home—their economy is destined to become stronger at our expense.

Perhaps our greatest hope lies in the wondrous ability of open communications in general and commercial television in particular to destroy traditions in a hurry. Japanese consumers have gone into a buying frenzy when a few stores have offered them goods at market prices. More and more young Japanese are questioning the traditions of hard work, long hours, and austere living that their parents docilely accept. Their free spirits and consumerist impulses have been aroused by what they read in the slicks and see on the soaps.

In other words, we may not be learning their good habits, but they're sure picking up our bad ones. The Japanese economic miracle may be one of the shortest on record.

LEONARD BEZARK, JR.
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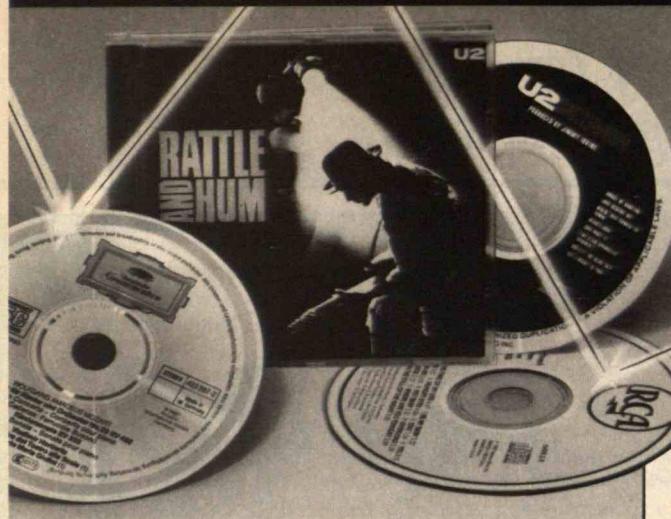


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180187. Bruce Hornsby & The Range: *Scenes From The Southside*. The Valley Road, more. (RCA)

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125179. Tchaikovsky, 1812 Overture; Nutcracker Suite; more—Solti. (London DIGITAL)

163629. Whitesnake. Still Of The Night, Give Me All Your Love, more. (Geffen)

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200596. U2: *Rattle & Hum*. Live set includes I Still Haven't Found What I'm Looking For, Desire, more. (Island)

182522. *Dirty Dancing*/Original Soundtrack. (I've Had) The Time Of My Life, more. (RCA)

200478. Metallica: *And Justice For All*. One, Blackened, title song, more. (Elektra)

100603. Kenny G: *Silhouette*. We've Saved The Best For Last, more. (Arista)

154404. *Chicago* 19. Don't Wanna Live Without Your Love, Heart In Pieces, etc. (Reprise)

115457. Itzhak Perlman: *French Violin Showpieces*: Carmen-Fantasy, Havanesa, more. (DG DIGITAL)

144578. The Judds: *Greatest Hits*. Concerto No. 23, Sonata No. 13 (DG DIGITAL)

152854. Whitney Houston: *Whitney*. Didn't We Almost Have It All, etc. (Arista)

150913. Van Halen: *OU812*. (Warner Bros.)

223559. Beach Boys: *Endless Summer*. 20 Greatest Hits.

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104898. Cream: *Disraeli Gears*. Sunshine Of Your Love, more. (Polydor)

173233. James Galway: *Greatest Hits*. (RCA)

154633. Steve Winwood: *Roll With It*. Don't You Know What The Night Can Do?, Holding On, etc. (Virgin)

100470. Vangelis: *Direct*. (Arista)

153582. Tracy Chapman: *Fast Car*, Talkin' Bout A Revolution, Baby Can I Hold You, etc. (Elektra)

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Concerto No. 23
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15436

100035. Robert Palmer: *Heavy Nova*. Simply Irresistible, etc. (EMI-Manhattan)

120768. 20 Greatest Love Songs Of The 50s & 60s. (Laurie)

123721. Jimmy Page: *Outrider*. (Geffen)

134321. Led Zeppelin: *Houses Of The Holy*. The Song Remains The Same, more. (Atlantic)

105392. *Pop In Space*—Boston Pops/Williams: Star Wars, Superman, more. (Philips DIGITAL)

173406. *Jazz CD Sampler*. 15 performances from Louis Armstrong, others! (PolyGram)

123790. James Taylor: *Greatest Hits*. Fire And Rain, Sweet Baby James, more. (Warner Bros.)

154537. Carly Simon: *Greatest Hits Live*. Anticipation, You're So Vain, more. (Arista)

115541. Bach, Brandenburg Concertos 1-3—Pinnock. (Archiv DIGITAL)

172190. Elvis Presley: *18 No. 1 Hits* (RCA)

134267. Mozart, Overtures. Marriner. (Angel DIGITAL)

100591. Steve Miller: *Born To Be Blue*. Ya, Ya, more. (Capitol)

273965. Sting: *Nothing Like The Sun*. We'll Be Together, more. (A&M)

134647. J. R. Baker: *Rhapsody In Electric Blue*. Gershwin on synthesizer! (Newport Classic DIGITAL)

244006. Simon & Garfunkel: *The Concert In Central Park*. [1 disc] (Warner Bros.)

124705. Jethro Tull: *Aqualung*. (Chrysalis)

134408. David Sanborn: *Close-Up*. Slam, You Are Everything, Way, etc. (Warner Bros.)

153606. INXS: *Kick*. Need You Tonight, New Sensation, etc. DIGITAL (Atlantic)

153621. Beethoven, *Symphony No. 7*; more. Royal Phil. Previn. (RCA DIGITAL)

130230. Crosby, Stills, Nash & Young: *So Far (Greatest Hits)*. Suite: Judy Blue Eyes, more. (Atlantic)

124546. The Moody Blues: *Sur La Mer*. I Know You're Out There Somewhere, No Lies, etc. (Threshold)

143293. Glenn Miller Orchestra: *In The Digital Mood*. (GRP)

114780. Cinderella: *Long Cold Winter*. Gypsy Road, Don't Know What You Got (Till It's Gone), etc. (Mercury)

154358. Slatkin Conducts Pictures At An Exhibition, more—(RCA DIGITAL)

144659. The Best Of The Spencer Davis Group. Steve Winwood & Co. on Gimme Some Lovin', etc. (EMI)

100352. Diane Schuur: *Talkin' Bout You*. Title song, Funny (But I Still Love You), etc. (GRP)

104857. Benny Goodman: *Sing, Sing, Sing*. Title song, more. (RCA)



100027. Alabama: *Live*. Love In The First Degree, There's No Way, Dixieland Delight, etc. (RCA)

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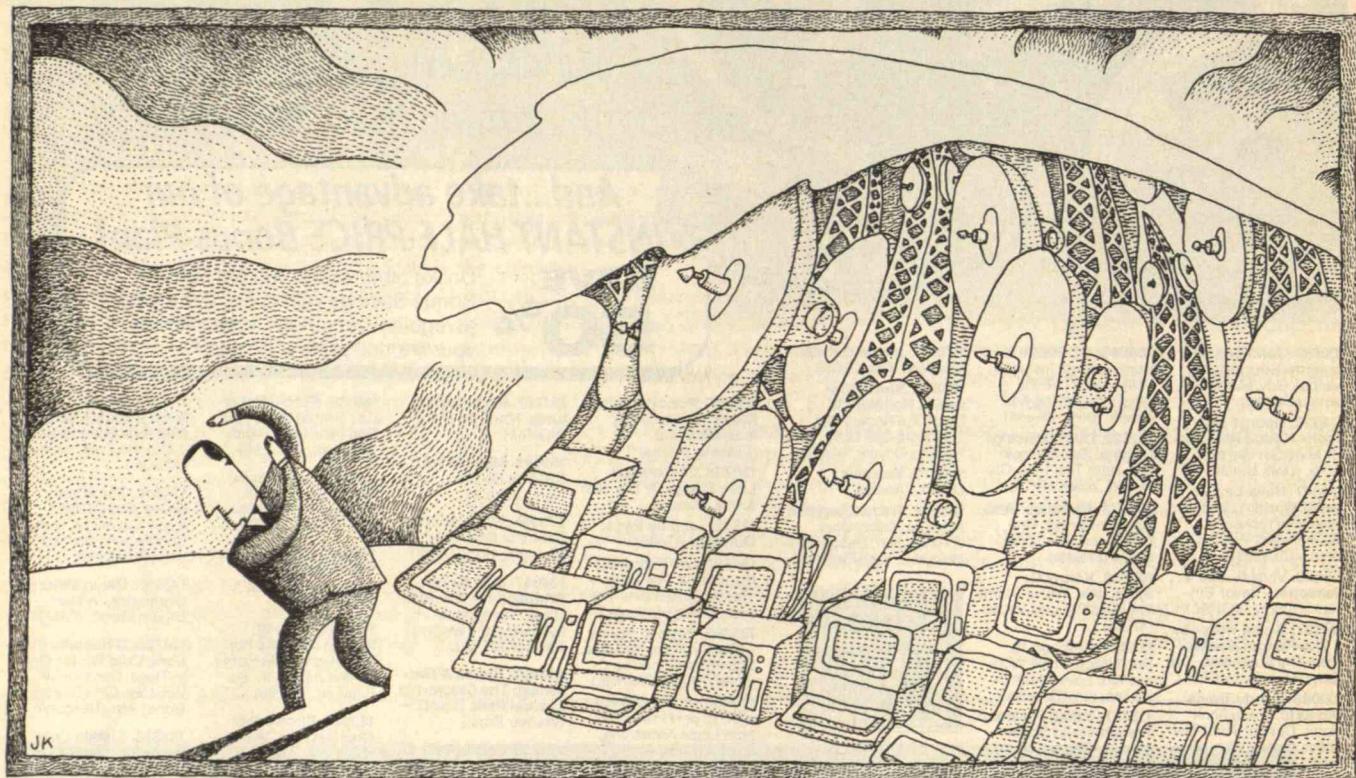
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The Danger of Ignoring Non-Ionizing Radiation



THIS year the U.S. Environmental Protection Agency is abandoning its 16-year-old non-ionizing radiation (NIR) program. The effort consisted of drafting exposure standards and, until 1986, conducting research on health effects. Soon only one EPA employee will continue to measure exposure levels.

NIR is the stuff of the information age, and it is everywhere. Because NIR is emitted by everything from broadcast towers to computer terminals, there is as much chance of eliminating it as there is of putting the atomic genie back into the bottle.

Yet an increasing number of studies have pointed to the possibility that NIR can promote cancer. More evidence is needed. And appropriate national exposure standards must be set for all types of NIR, through unified federal action.

Richard Guimond, head of EPA's radiation office, explained the decision to do away with the agency's NIR program by saying there is insufficient evidence of a

*Industry
and the public
can expect
continuing controversy
over exposures.*

health problem from non-ionizing radiation. His statement is premature because a separate cancer assessment group within EPA is still conducting a study on NIR. Moreover, few other scientists now are trying to answer the health question, and what little activity there is suffers from inadequate funding.

Guimond also said that neither Congress nor the public has issued a mandate for setting federal NIR exposure standards. But there is a mandate of sorts. Although the public is largely unaware that NIR emissions from military radar have anything in common with those from elec-

tric blankets, people all over the country have become concerned about various forms of NIR. The San Francisco community living in the shadow of the huge Sutro broadcast tower worries about radiation and is trying to block the addition of any radio or television antennas. Families in Boca Raton plan to boycott a new school built next to a power line. In 1987, city planners for Portland, Ore., set their own exposure standards for broadcast radiation. And office workers throughout the United States are anxious about the effect of computer terminals on pregnant women.

The business community has also been counting on EPA to settle the health issues. It wants local communities to stop setting their own exposure standards and challenging facilities that emit NIR. Jay Branderger, president of the Electromagnetic Energy Policy Alliance and a vice president at SRI International, calls EPA's decision a "very unfortunate and giant setback."

And several NIR experts in different federal agencies are more than a little annoyed at the decision. Dissidents include EPA's own Science Advisory Board. "At a minimum, the agency must continue to monitor research in this field and provide

LOUIS SLESIN is editor and publisher of *Microwave News*, a newsletter based in New York City that covers the health effects of NIR. His doctoral work at MIT concerned environmental risk analysis.

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technical support and assistance [about NIR] to other federal agencies," the board wrote EPA Administrator Lee Thomas last July. "It is imperative that a viable federal presence be maintained in this area."

A Link to Cancer?

A cynical outlook common to policy analysts is that the prospects for safety regulations are poor without dead bodies. In 1987, David Carpenter, who headed a \$5 million research project funded by New York state utilities and run by the state Department of Health, came up with a striking body count. He estimated that 30 percent of all childhood cancers may be due to exposure to extremely low-frequency electromagnetic fields such as those produced by power lines. If this is true, 2,000 American children a year would be affected. Carpenter, who started the project as a skeptic, also concluded that roughly 4,000 adult cases of cancer a year might be related to these NIR fields. These studies suggest that any thresholds for ill effects may be much lower than previously believed.

Other research indicates that cancer may also be caused by the higher NIR frequencies associated with radar, radio, and television. In 1987, the Hawaii Department of Health found that Honolulu residents living near radio and TV towers had a significantly higher incidence of cancer than those living elsewhere in the city. And in Poland, soldiers exposed to NIR from radar and communications equipment showed up to a sevenfold increase in certain types of cancer.

Scientists have yet to agree on mechanisms by which NIR fields may affect cancer development. Ross Adey's lab at the Veterans Administration hospital in Loma Linda, Calif., has come up with a plausible hypothesis for weak NIR signals, such as those from power lines. The key process seems to be that the signal is amplified on the surface of the cell membrane before being transmitted to the cell's interior. (See "Power Lines and Cancer," October 1987.) Other researchers are pursuing other explanations.

It appears that living systems are extraordinarily sensitive to different NIR fields. Last June, writing in the *Proceedings of the National Academy of Sciences*, biologists Reba Goodman of Columbia University and Ann Henderson of Hunter College showed that small changes in fre-

quency lead to the synthesis of different types of cell proteins.

Scattered Work

The task of sorting out possible health risks from the many uses of NIR remains gargantuan. At this point, the responsibility for researching and regulating the effects of non-ionizing radiation is scattered over more than 15 different parts of the government. For instance, the Federal Communications Commission regulates radiation from television, radio, and cordless and cellular telephones. The Food and Drug Administration regulates electronic devices such as computer terminal screens and electromagnetic medical devices. The Department of Defense (DOD) monitors its communications facilities and radars. And the Department of Energy (DOE) sponsors studies on the health effects of power lines.

Each agency goes its own way and there is practically no coordination of research or regulation. That used to be the job of the Department of Commerce's Electromagnetic Radiation Management Advisory Council (ERMAC), before the Reagan administration refused to renew its charter. ERMAC was set up in 1968, two years before EPA.

Another problem is that with EPA bowing out of the NIR question, most of the work will be done by agencies that have a large stake in downplaying the risks. DOD and DOE already pay for some 90 percent of all NIR research.

Widespread confidence in NIR-producing technology can be restored only by the full participation of the federal agencies whose missions concern public health. The only viable approach is a coordinated research program—run by the Environmental Protection Agency and the National Institutes of Health—leading to credible exposure standards. But these agencies need a congressional mandate and money to carry it out.

By addressing each radiation source separately, the federal government makes the NIR problem appear less pressing and easier to ignore than it actually is. Until EPA and the National Institutes of Health start treating the NIR spectrum as a whole, industry and the public can expect more controversy, further development of a crazy quilt of local regulations, and still more delays in siting new transmitters and power lines. ■

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AMANN	BARKLEY	BENSON	BROKELL	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
AMBER	BARLOW	BENT	BROKELL	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
AMBROSE	BERRY	BENTLEY	BROKELL	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
AMES	BARNES	BENTON	BONNIEY	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
AMMANN	BARNETT(1)	BENITZ	BOOKER	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
AMMON	BARNET	BERGEN	BROOKIE	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ANDERSON	BARNUM	BERGIN	BROOKIE	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ANDREWIS(1)	BARRELL	BERINGER	BROOKIE	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ANGELL(1)	BARRETT	BERNARD	BROOKIE	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ANTHONY	BARRINGER	BERRY	BROOKIE	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
APPLEGAY	BARRY	BERRYMAN	BROOKIE	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
APPLEGATE	BARRY	BERRYS	BROOKIE	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
APPLETON	BARTHOLOMEW	REST	BOUCHER	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ARCHER	BARTLETT	BETHUNE	BOUGHTON	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ARDMELD	BARTON	BETTS	BOYD(1)	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ARMISTEAD	BARTOW	BETTS	BOYD(2)	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ARMITAGE	BASHORE	BEVERIL	BOYD(EY)	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ARMSTRONG	BASSE	BEYER	BOYD(EY)	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ARNETT	BASSET(1)	BIBB	BOYD(EY)	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ARTCHILL	BICKEL	BODD	BOYD(EY)	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ARNOLD	BICKEL	BOKER	BOYD(EY)	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ARNOTT	BICKEL	BOKER	BOYD(EY)	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ARROWSMITH	BOTEMAN	BICKNELL	BOYD(EY)	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ATKINS	BAUMAN(1)	BILLUPS	BOYDINGTON	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ATKATER	BAUMAN(1)	BINNS	BOYD(1)	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ATWATER	BAULESS(1)	BIRCH	BOYD(1)	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ATWELL	BAULESS(1)	BIRCH	BOYD(1)	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ATWELL	BAULESS(1)	BIRCH	BOYD(1)	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ATWOOD	BAYLOR	BIRDSALL	BRACKETT	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
AUBREY	BAUN	BIRDSALL	BRACKETT	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
AUSTIN	BEACH	BISBEE	BRADBURY	BULLARD	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ATCHISON	BAUGHMAN	BILLINGTON	BODDEN	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ATHERTON	BAUM	BILLIS	BODDEN	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ATKINS	BAUMAN(1)	BILLUPS	BOYDINGTON	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ATWATER	BAULESS(1)	BINNS	BOYD(1)	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ATWELL	BAULESS(1)	BIRCH	BOYD(1)	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
ATWOOD	BAYLIS(1)	BIRCH	BRACKETT	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
AUBREY	BAUN	BIRDSALL	BRACKETT	BURSTON	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
AVERELL	BEACHAM	BISHOP	BRADBURY	BULLARD	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
AVERY	BAE(HM)	BISSELL	BRADBURY	BULLARD	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
AXTELL	BAE(HM)	BISSELL	BRADBURY	BULLARD	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
AYFR(E)	BEAM	BLACKBURN(E)	BRAGDON	BUNCE	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
AYRES	BEA(HM)	BLACKMAN	BRAGG	BUNDE	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
BABBITT	BEANE(1)	BLACKMORE	BRAGH	BUNDY	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
BABCOCK	BEAN	BLACKMORE	BRAGH	BUNDY	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
BABER	BEARD	BLACKMORE	BRAGH	BUNDY	BURSTON	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
BACH(E)	BEARDSLEY	BLACKWOOD	BRAGH	BUNELL	CASS	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
BACHMAN(1)	BEASLEY	BLADE(S)	BRANCH	BUNTING	CASSADY	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
BACON	BEASON	BLADE(S)	BRAND	BUNTON	CASSADY	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
BADGECK	BEATON	BLADE(S)	BURBIDGE	BURBANK	CASSEL(1)	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
BADGER	BEATTIE	BLAKE	BURCH	CASSEL	CASSEL(1)	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE
BADGLEY	BEATTIE	BLAKE(1)	BLAKE(1)	BRANNAN	BLAUCHARD	CHAPLIN	COFFEE	FISHER	FYCH	GRUBBLE

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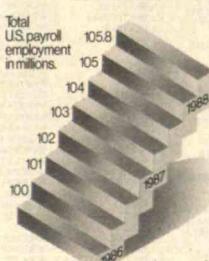
With so many things to worry about why are we so optimistic?

Those inclined to worry will always find things in the economy to worry about. But the fact is, Merrill Lynch research shows that many untapped investment opportunities are unfolding. And we believe the time to take advantage of them has arrived. Here are those trends. And what the astute investor can do about them.

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The basic economy is sound.

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Assessing the Investment Climate

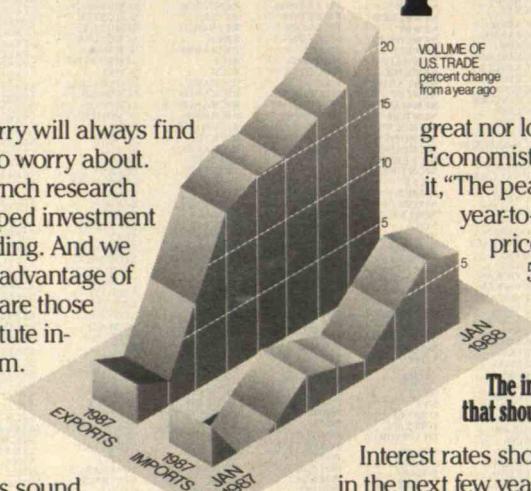
Inflation Jitters—Valid but Exaggerated Concerns

The memory of double-digit inflation in the late 1970s has a pronounced effect on financial market behavior today. The reaction vigorously and harshly to any signs of incipient inflation, the response of the markets influences monetary policy, the response of the yield curve, an indicator of inflation expectations.

Lynch Chief Investment Strategist Charles I. Clough points out, "Foreign investment flows into dollar-denominated financial assets are likely to be increasingly supportive of the U.S. financial markets."

Inflation is up. But not severely.

While the drought in the Midwest is boosting food prices, the overall effect should be neither

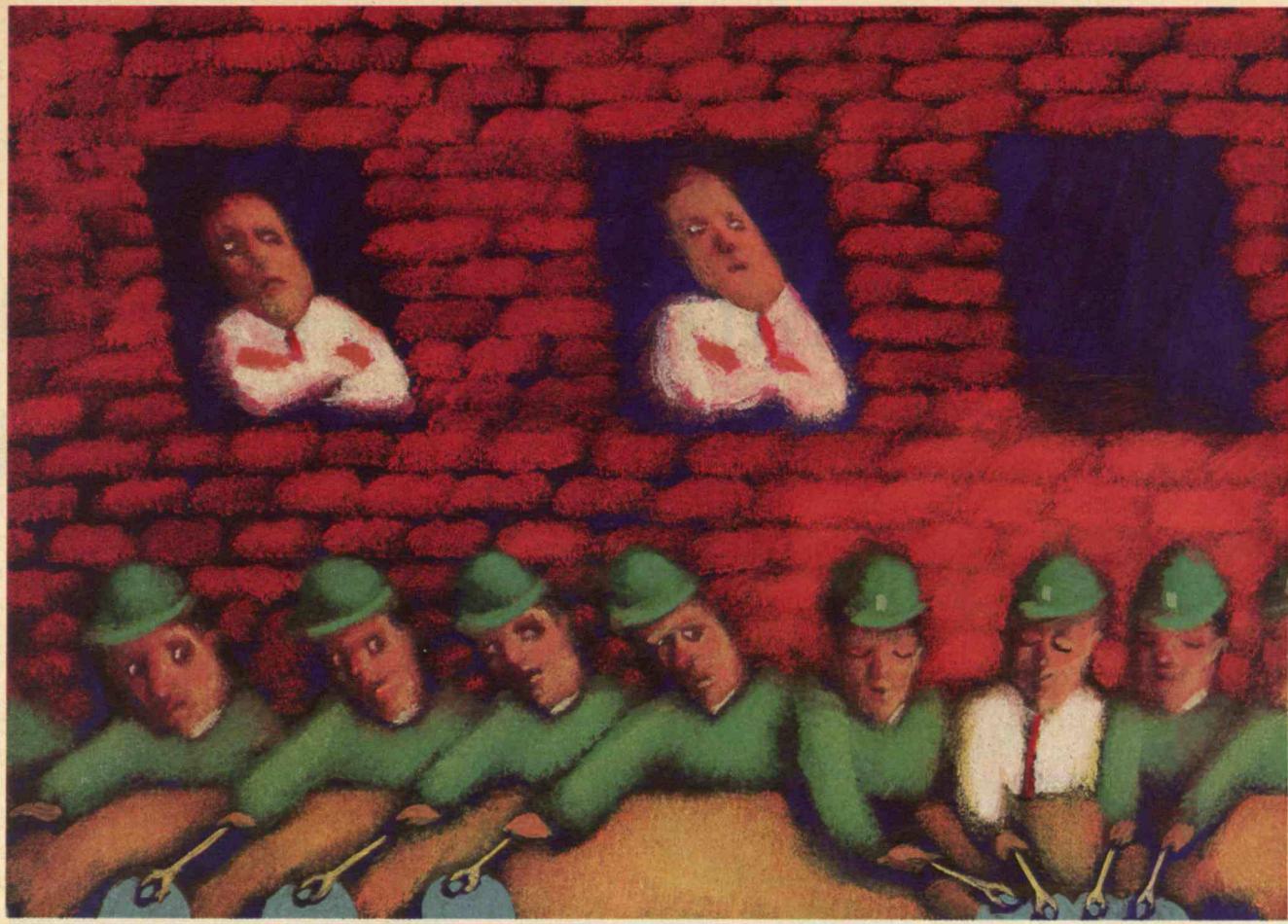


VOLUME OF U.S. TRADE

percent change

from a year ago

from a



Reorganizing Work: The Auto Industry Enters the 1990s

When Detroit sneezes, the country's economy catches a cold." Whether this adage is as true as it used to be, the U.S. auto industry remains the bulwark of our nation's manufacturing economy. During the past decade, U.S. automakers have had a cold of major proportions. Increased international competition and declining market share are forcing companies to rethink the basics of their industry—technology, work organization, labor relations. One of the test-beds for that rethinking has been the Fremont, Calif., plant of New United Motor Manufacturing, Inc., or NUMMI, a joint venture of General Motors and Toyota. The following two articles continue *Technology Review's* ongoing analysis of the NUMMI experience.

Technology Review's ongoing analysis of the NUMMI experience. In a recent issue, Mike Parker and Jane Slaughter argued that NUMMI's "team concept" makes autoworkers' jobs more stressful. (See "Management by Stress," October 1988.) In this issue, former NUMMI engineer John F. Krafcik, a participant in MIT's International Motor Vehicle Program, describes the key principles for managing production at NUMMI and explains how these principles have made it one of the most productive auto plants in the United States. Finally, University of California researcher Lowell Turner describes how three different plants have experimented with the team approach to work organization and examines what it will take to make teams work in the auto industry.

A New Diet for U.S. Manufacturing

BY JOHN F. KRAFCIK



A study of the international auto industry suggests that high performance depends on creating "lean" production systems.



A U T O
I N T H E
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SINCE 1981, General Motors Corp. has invested more than \$40 billion in a comprehensive effort to modernize its production technology. That's enough to buy the entire Toyota Motor Corp. outright, but it has done little to improve the performance of the world's largest corporation. GM's share of the U.S. car market has dropped from 45 to 37 percent, and profitability has also fallen, under the double impact of weak sales and the soaring fixed costs caused by all that new technology.

By contrast, in 1984 GM invested a mere \$200 million in an innovative joint venture with Toyota—New United Motor Manufacturing, Inc., or NUMMI. Using workers and facilities GM had abandoned just a few years earlier and equipment best described as "medium tech," the NUMMI plant in Fremont, Calif., has achieved productivity levels 40 percent better than typical GM assembly plants, as well as the highest quality levels GM has ever known.

The key is the plant's system for managing production. Most of the original managers at NUMMI were Toyota executives from Japan, trained in an approach common there but still rare in the United States—one that lowers costs while improving quality and increasing flexibility.

At a time when the U.S. trade deficit is the greatest in history—with the automotive sector alone accounting for over one third of it—more and more American manufacturers are paying attention to the nuts and bolts of production management. Assimilating the lessons of NUMMI is crucial to rebuilding U.S. manufacturing competitiveness.

A production system is nothing more than a set of tools, a group of people, and some guidelines under which they operate. Given the same tools and the same number of people, it is quite likely that two different companies will achieve different levels of productivity and quality. The explanation for this lies primarily in the guidelines for how workers are managed and trained, how the tools are arranged, even how workers are expected to interact with their tools.

The world automobile industry has recently wit-

nessed the start of a shift between two production-management styles—what I call the "buffered" and the "lean" approach. First developed in the United States, buffered production systems are characterized by large stocks of inventory, large repair areas, and narrowly specialized workers. "Lean" production systems, which were pioneered by Japanese automakers, operate with small inventory stocks, small repair areas, multi-skilled workers, and a "team" approach to work organization.

My experience both as a quality-control engineer at NUMMI and, more recently, as a researcher for MIT's International Motor Vehicle Program has convinced me that the lean production system is crucial to achieving high performance in the automobile industry and other durable-goods manufacturing sectors. In a study that has taken me through more than 60 assembly plants in 15 countries, I found that lean operations are consistently more productive, more flexible, and more apt to produce high-quality products.

For example, of the 38 plants considered in Figure 1 (see page 31), nearly all those with lean policies have productivity better than the mean of 28.4 hours per vehicle. Most of the buffered plants, by contrast, are worse than the mean—with some reaching as high as 50 hours per vehicle.

Moreover, lean production management has been a central factor in the worldwide success of the Japanese auto industry. Plants owned by Japanese auto producers are consistently leaner than their U.S. and European counterparts (see Figure 2, page 32). In fact, the leanest U.S.-owned plants in North America are still more buffered than the most buffered Japanese-owned plants in either Japan or the United States, and this fundamental difference has had a direct impact on productivity (see Figure 3, page 32).

JOHN F. KRAFCIK is a research affiliate of the International Motor Vehicle Program at MIT and founder of the Houston-based consulting firm Competitive Manufacturing Research. He holds a degree in mechanical engineering from Stanford University and one in management science from MIT. From May 1984 to June 1986, Krafcik worked as a quality-control engineer at NUMMI's Fremont plant. A longer version of this article appeared in the fall 1988 issue of the Sloan Management Review.

Lean production management

*does not depend on the cultural attributes of a particular nation—
as popular attention to “Japanese management”
sometimes suggests.*

The most productive U.S. plant, at 19 hours per vehicle, performs only slightly better than the average Japanese plant, at 19.1 hours. But the best Japanese plant has a 3-hour advantage over its closest U.S. rival.

The Japanese edge is even greater when it comes to quality (see *Figure 4*, page 33). The average Japanese assembly plant has about half as many defects as its American and European competition. The very best U.S. performance—58 defects per 100 vehicles—is still behind the Japanese average of 52 and little better than the worst Japanese showing, which is 66 defects.

Japanese auto producers are also using lean production to create highly flexible systems that can quickly respond to changes in demand (see *Figure 5*, page 33). According to a measure based on how complex a mix of models a particular facility can produce, the average Japanese plant is 53 percent more flexible than a U.S.-owned North American one, and 87 percent more flexible than those located in Europe and owned by European companies.

However, these figures should not be taken as evidence of the manufacturing invincibility of the Japanese. When U.S. companies organize production according to the lean approach, they can achieve performance levels on par with and sometimes even better than those of the Japanese. For instance, as one U.S. automaker has implemented more and more lean production-management policies, in effect altering its corporate culture step by step, its productivity has increased remarkably. Three out of the four U.S. plants in our study that combine lean management with high productivity all belong to this corporation (see *Figure 6*, page 34).

Thus, creating a lean production system does not depend on the cultural attributes of a particular nation, as the popular attention to “Japanese management” sometimes suggests. American workers can learn the principles of lean systems just as well as Japanese workers can, which bodes well for U.S. manufacturers competing in the world marketplace.

Finally, the success of the lean production system stems in no way from advantages in technology. Indeed, the relationship between technology, productivity, and flexibility is a murky one. Some of the most productive plants, particularly the Japanese, do have a lot of new technology. Other very productive plants, often American, do not (see *Figure 7*, page 34). And many plants with advanced manufacturing

technology still have not realized the degree of flexibility that such technology is supposed to make possible (see *Figure 8*, page 34).

The implication is that plants with older technology can be made lean, flexible, and productive just as plants with the latest in high-tech gadgetry can still be buffered, inflexible, and unproductive. In fact, achieving high performance at an automated facility seems to require that a lean production system is already in place.

Why Lean Plants Are More Productive

What makes lean production systems more efficient? Answering that question requires examining the contrasting logic of the buffered and lean approaches.

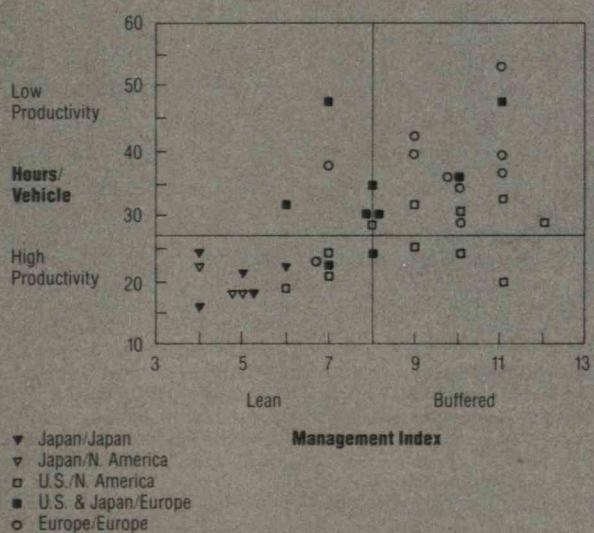
As the name suggests, the purpose of buffered production management is to cushion the system from any and all unforeseen events. Consider the example of plant inventory. In an ideal world, a company would have on hand only those parts necessary to complete the products currently on order from customers. Idle inventory—whether parts from suppliers, work in progress, or finished goods—has no real value until the product is sold. Any firm would rather have the monetary value of idle inventory sitting in a bank account and earning interest.

However, the world of manufacturing is never ideal. Keeping large stocks of excess inventory on hand ensures that production is protected from unanticipated problems—an approach sometimes known as the “just-in-case” syndrome. The common attitude goes something like this: “We keep two weeks of this part in our plant just in case the supplier goes on strike, just in case their plant gets snowed in, or just in case we have a quality problem with the part.”

But what on the surface may seem like a sensible defense against uncertainty is, in fact, the source of the buffered system’s performance disadvantage. Not only are valuable resources tied up in idle inventory but quality problems often go unheeded. When a particular part proves defective, selecting another one from the ample “safety stocks” is far easier than finding out what’s causing the problem. Such a short-term “solution” can make for serious difficulties in the long run.

For this reason, lean production-management policies eschew the “just-in-case” approach for a philosophy known as “just-in-time” (also sometimes

Figure 1: The Lean Advantage



This figure and those that follow compare U.S.-, Japanese-, and European-owned automobile plants around the world. Here, productivity (measured in hours of labor per vehicle) is correlated with a "management index." The latter indicates the

leanness of each plant based on such factors as unscheduled absenteeism, use of the team concept, and percentage of floor space set aside for repairs. Lean plants are consistently more productive than their buffered counterparts.

called the "pull" method or described by the Japanese term *kanban*). The strategy is to work as closely to the ideal situation as possible so that everyone—producer and suppliers alike—keeps improving production until they get things right.

The just-in-time method is similar to Henry Ford's original idea of continuous-flow production—the principle that the most efficient way to make something is to minimize the amount of time between the start and the finish of manufacturing and assembly. But whereas Ford achieved this through high volume, standardized products, and vertical integra-

tion, Japanese automakers use a network of small suppliers. That way, they can combine continuous flow with the flexible manufacture of many different kinds of products, something Henry Ford never attempted.

At a traditional Western buffered plant, the supplier of, say, automobile instrument panels ships hundreds of them every few days to the assembly-plant warehouse, where they sit until delivery to the line. How many blue, brown, or deluxe panels are included in each shipment depends on projections of managers at the plant. If production does not keep to these projections, some of the instrument panels may not be needed, while others may be in short supply.

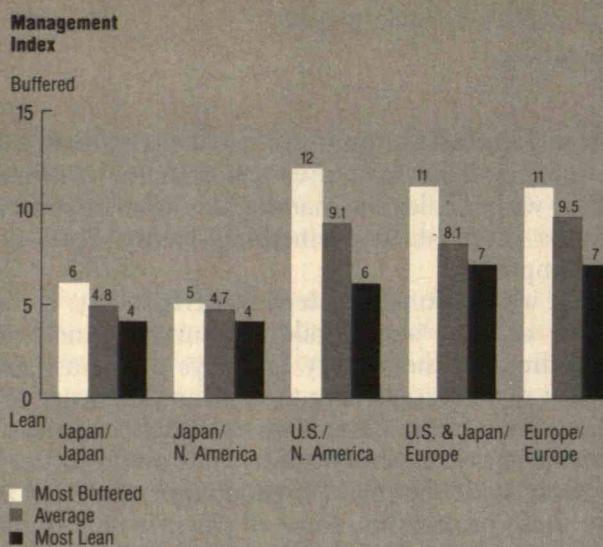
In a just-in-time system, on the other hand, the instrument-panel supplier, ideally located within an hour or so of the assembly plant, doesn't receive the order for a particular panel until the last minute, after the plant has already started building the car. The supplier often has less than one eight-hour shift to fill the order. Deliveries are commonly scheduled every hour or two, with the panels loaded on the truck in the same sequence as the cars coming down the assembly line.

Of course, this means that lean plants must be able to count on high quality from their suppliers. But rather than impeding efficiency, that expectation becomes an enormous incentive for suppliers to carefully monitor and improve their own work process. In this way, productivity and quality improvements continuously ripple through the entire system.

In Japan, high-quality lean suppliers have had years to develop. In the United States and other Western countries, however, they have had to learn quickly. When GM and Toyota began planning the NUMMI joint venture in 1984, one very important issue was where to get components. Both partners preferred to use as many North American suppliers as possible, yet few of them had ever dealt with a lean producer like Toyota. So Toyota and NUMMI engineers, myself included, worked closely with the 70 North American suppliers selected. In some cases, the company responsible for supplying Toyota in Japan helped its North American counterpart establish a lean production process.

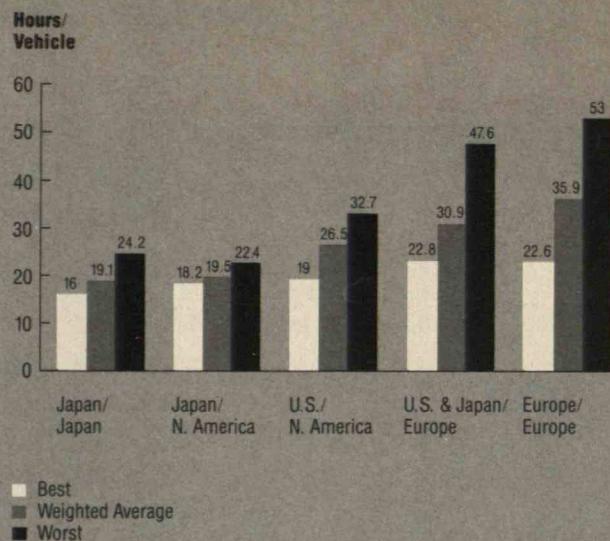
During the production start-up period, NUMMI found three times as many defects in North American-supplied parts as in Japanese-supplied parts. But over the last four years, North American sup-

Figure 2: Styles of Production Management



Japanese-owned plants are leaner than their U.S. and European competitors. The leanest U.S. plant scores the same on the management index as the most buffered Japanese facility.

Figure 3: Productivity



Leanness allows Japanese facilities to turn out vehicles faster. The most productive U.S.-owned plant in North America performs only slightly better than the

average Japanese-owned plant in Japan. And the best Japanese plant has an advantage of three hours per vehicle over its U.S. counterpart.

pliers have improved steadily and now achieve quality, delivery, and cost levels comparable to their Japanese competitors.

For the same reason buffered plants have high inventory—the desire to protect production from all possible problems—they usually have huge repair facilities. Yet my own experience in contemporary plants of both the lean and buffered type suggests there is a corollary to the law that says work expands to fill the time available: the number of defective products expands to fill the floor space set aside for them. I took two extensive tours through a large Toyota plant in Japan before I discovered any repair space at all—just enough for about 5 defective cars in a plant that produces 150 cars per hour! By contrast, one famous specialty producer in Europe had a repair area about half the size of the entire assembly floor, filled with defective cars.

Buffered plants must be substantially larger than lean plants to make room for all the extra inventory and repair areas. But larger plants lead to greater initial investment costs, less efficient material flow, diminished communication among departments, and increased maintenance and utility charges, thus contributing to overall inefficiency.

The New Role for Workers

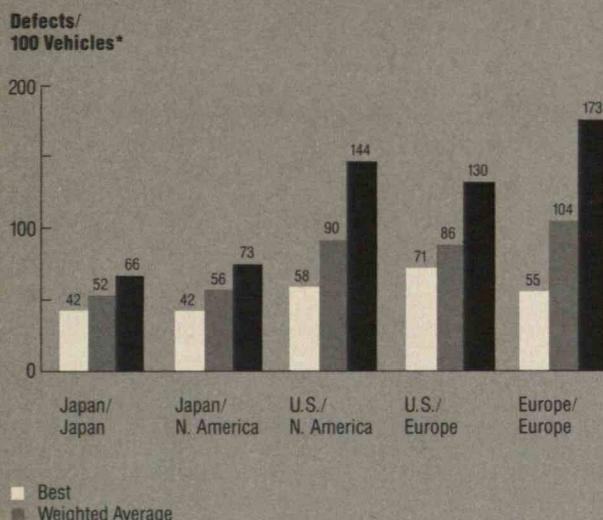
Production-management policies don't just affect how inventory is organized or how plants are designed. Perhaps the most important differences between buffered and lean systems concern the roles that workers play.

The first horseless carriages were custom-made by craft workers. Because production relied in great part on the skill of the workers themselves, they exercised a great deal of discretion in performing their jobs.

Henry Ford replaced the custom-made parts and skilled workers of the infant auto industry with a highly standardized and mechanized work process, operated by unskilled workers. The tasks on the assembly line were narrowly defined and highly standardized—often less than a minute in duration and repeated hundreds of times in each shift. Such repetition bred increased efficiency, and since management controlled the details of production, uncertainty was minimized. To this day, buffered plants fragment jobs and limit worker discretion.

But that approach has its costs. Workers with excessively narrow jobs lack knowledge about or in-

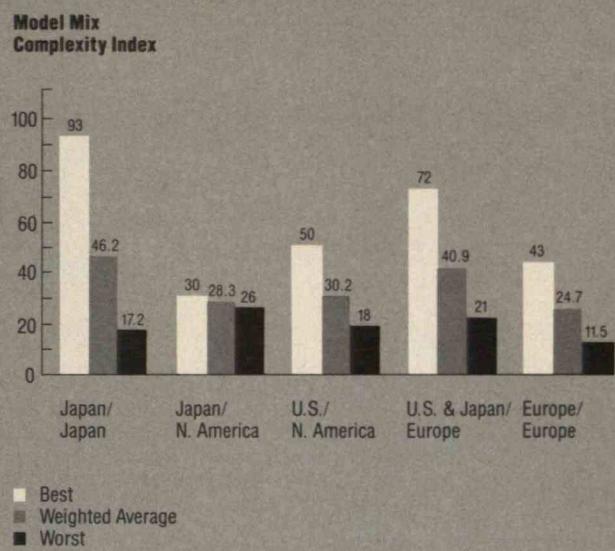
Figure 4: Quality



*Derived from 1988 J.D. Power Survey

When it comes to quality, the Japanese advantage is especially marked. The average Japanese plant produces vehicles with about half as many defects as its U.S. and European competition.

Figure 5: Flexibility



The "complexity index" measures plant flexibility by assessing how great a mix of models a particular facility can produce. The average Japanese plant is 53

percent more flexible than a U.S.-owned one in North America, and 87 percent more flexible than those located in Europe and owned by European companies.

terest in the work organization as a whole. As a result, the company loses any ideas they might have had for how to do things more efficiently. This has prompted the best Japanese producers, led by Toyota, to reintroduce a broader sphere of worker discretion, reminiscent of the craft era, while retaining Ford's emphasis on standardization and scientific management. Rather than treat workers as replaceable cogs in a great production machine, lean plants train them for a variety of tasks.

For example, workers do simple maintenance chores themselves. After all, they use the machinery hundreds of times each day and understand how it should work better than anyone. And unlike their buffered counterparts, they help develop the standardized sequences they spend most of their time performing.

In fact, as line workers in lean plants gain experience, they are expected to improve the production system by proposing new ideas. This process is known by the Japanese term *kaizen*, meaning "continual improvement." Kosuke Ikebuchi, head of manufacturing at NUMMI while I was an engineer there, describes the logic of *kaizen* this way: "Our 2,100 production team members are on the shop

floor eight hours a day, while our 30 engineers are on the shop floor perhaps only two hours a day. This is a great difference in experience. To be effective, a plant must use its production workers' ideas. To do otherwise is to waste a tremendous resource. The engineer's main job is to support the ideas of the production workers, not tell them what to do."

To facilitate the *kaizen* process, workers in lean plants also have many more opportunities for education and training. NUMMI workers receive over 250 hours of training during their first six months on the job, while a typical buffered-plant worker is lucky to receive 40 hours of training in the first year. About 75 hours of the training at NUMMI take place in the classroom, where workers learn the company's management philosophy and study techniques for control, safety, problem solving, and work standardization. For every subsequent year of employment, they receive another 50 hours of training in areas such as standardization techniques, the principles of *kaizen*, and leadership development.

During much of 1987 and 1988, NUMMI production was running at a mere 65 percent of capacity, yet the company didn't lay anyone off. Instead, NUMMI used this period as an opportunity to train.

Figure 6: A Lean U.S. Producer

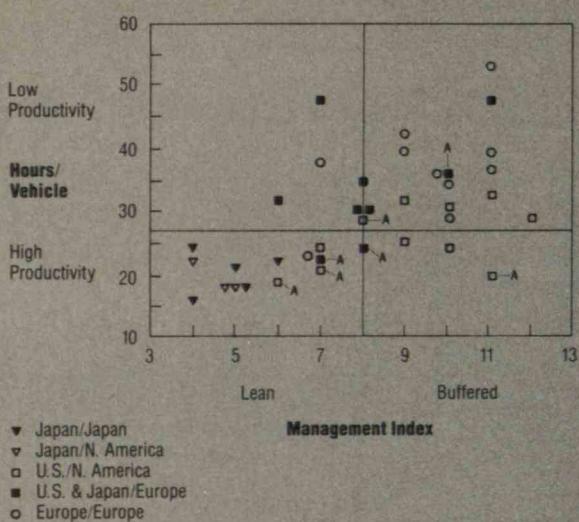


Figure 8: Technology and Flexibility

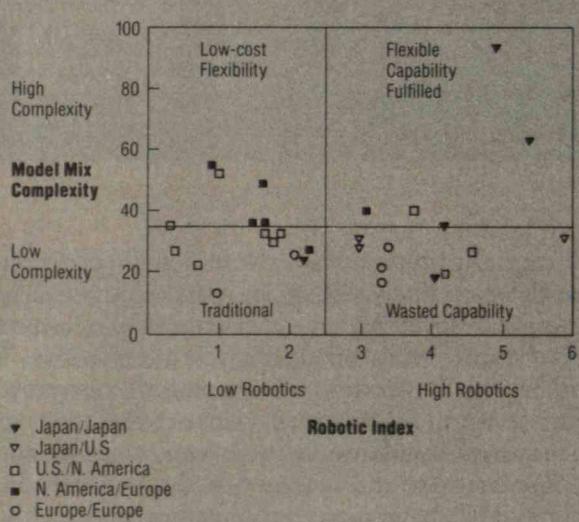


Figure 7: Technology and Productivity

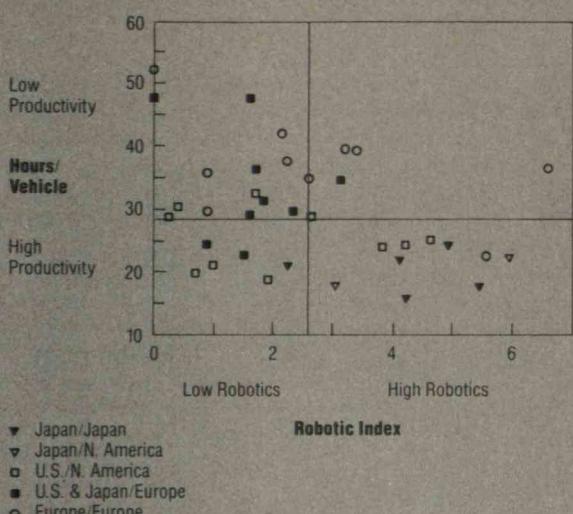


Figure 6: U.S. auto-makers can learn the lessons of lean production management. For example, three of the four U.S.-owned plants in the quadrant that denotes both leanness and high productivity belong to the same firm, known here as "Company A." As this company has introduced more lean policies, its productivity has increased remarkably.

Figure 7: The "robotic index" measures the amount of new technology in a particular plant. While some of the most productive plants, particularly the Japanese, do have a lot of new technology, other very productive facilities, mainly U.S.-owned, do not.

Technology in a particular plant. While some of the most productive plants, particularly the Japanese, do have a lot of new technology, other very productive facilities, mainly U.S.-owned, do not.

Figure 8: A great many plants with high scores on the robotic index do poorly on the complexity index. The implication is that they have yet to realize the increased flexibility new technology is supposed to make possible.

As sales of the Chevrolet Nova and Corolla FX produced at the plant slowed, teams were taken off the production line. They spent some time in classes and the rest designing production processes to launch the new Toyota Corolla and GM's Geo Prizm in the fall of 1988.

The team concept is another Japanese innovation that redefines the role of workers. Consisting of roughly five to seven members and managed by a leader, the team is the basic unit of shopfloor responsibility. Members oversee quality, cost, safety, and the overall improvement of the production pro-

cess in their area, helping each other to achieve the group's collective goals.

The advantages of such a system are readily apparent at the NUMMI plant. Team leaders have many of the same duties as traditional shop foremen, such as general supervision and record keeping. However, unlike foremen, they belong to the autoworkers' union, so many problems that would end up as formal union grievances at buffered plants can be solved informally within the team.

Team leaders are also able to perform assembly-line tasks should the need arise. This lends an extra



Harry Selker, M.D.
Boston, Massachusetts

AFTER SPENDING 12 YEARS IN AN EMERGENCY ROOM, HE'S GLAD HE DRIVES A VOLVO.

Harry Selker bought his first Volvo because it was a tough, durable, reliable car.

And because back when he bought it, in the 1960's, driving a Volvo seemed

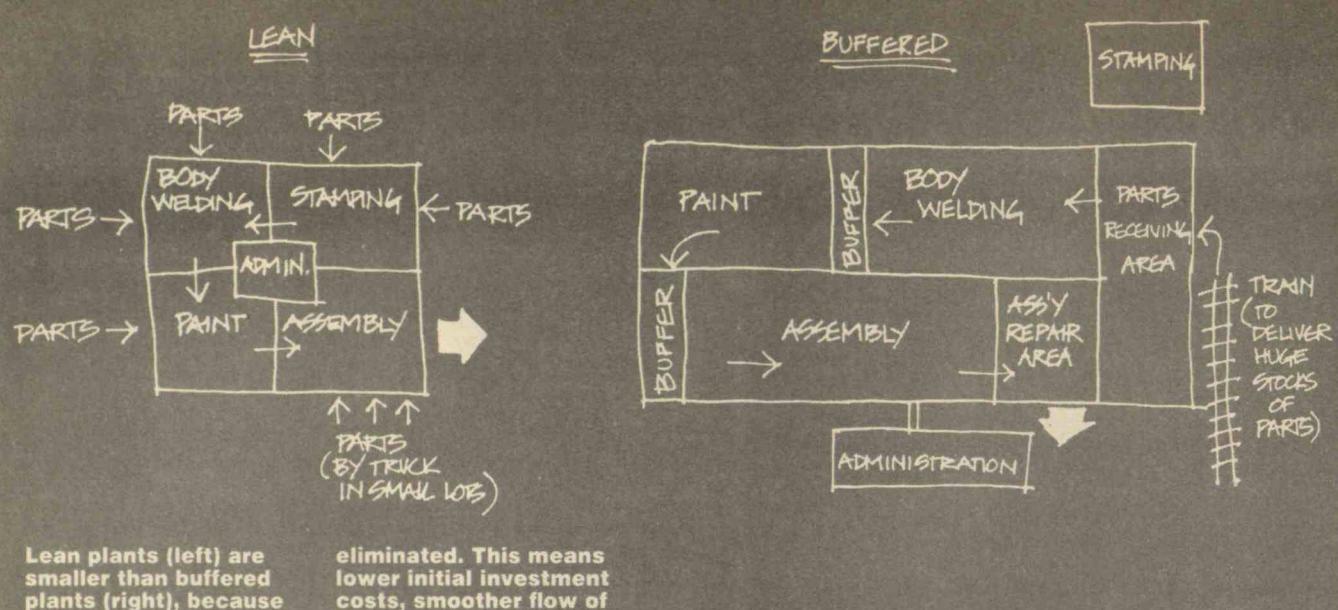
like the anti-establishment thing to do.

But after 12 years of working in emergency rooms and hospitals, seeing the results of numerous

automobile accidents, Dr. Selker has discovered another reason for driving a Volvo.

It seems like the only intelligent thing to do.

VOLVO
A car you can believe in.



measure of flexibility to the work force and, interestingly, discourages unscheduled absenteeism. Before the Fremont plant was organized according to lean principles, it had an absenteeism rate of about 20 percent, high even by the standards at buffered plants, where absenteeism usually ranges between 10 and 15 percent. But now absenteeism has dropped to a level of about 4 percent, one of the best in the industry. Although many factors have contributed to NUMMI's low unscheduled absenteeism rate, the team concept has been crucial. Since team leaders are often obliged to cover for members who do not show up, there is a subtle but powerful pressure to maintain high attendance rates.

In addition, the team concept allows an elegant solution to the problem of "balancing the line"—reassigning tasks quickly to cope with new models or unexpected changes in the product sequence. Altering one worker's sequence usually requires altering the sequence of many others as well, which results in short-term chaos at buffered plants. Until the industrial engineering group can find an appropriate "balance," some of the plant's utility workers, kept on hand for just such a contingency, fill in the holes. But because workers at a lean plant are trained in the techniques of scientific management and work standardization, they can react to changes in a systematic and coordinated way by shifting task elements among teams.

For example, when the Toyota Corolla was added to the production mix of the Fremont plant, it created a problem for the teams in the engine and chassis assembly areas. The exhaust pipes on the

assembled engines interfered with the fixtures that the chassis group was using to attach the engine to the body of the car. The teams solved the problem by shifting the job of exhaust-pipe assembly from the engine to the chassis group, which set up a separate station off the assembly line for putting together the exhaust pipe and installing it on the vehicle. The result was a more efficient distribution of work and less damage to parts and tools. Moreover, the exhaust subassembly no longer had to be transported across a slippery area of the plant, so the new work procedure was safer, too.

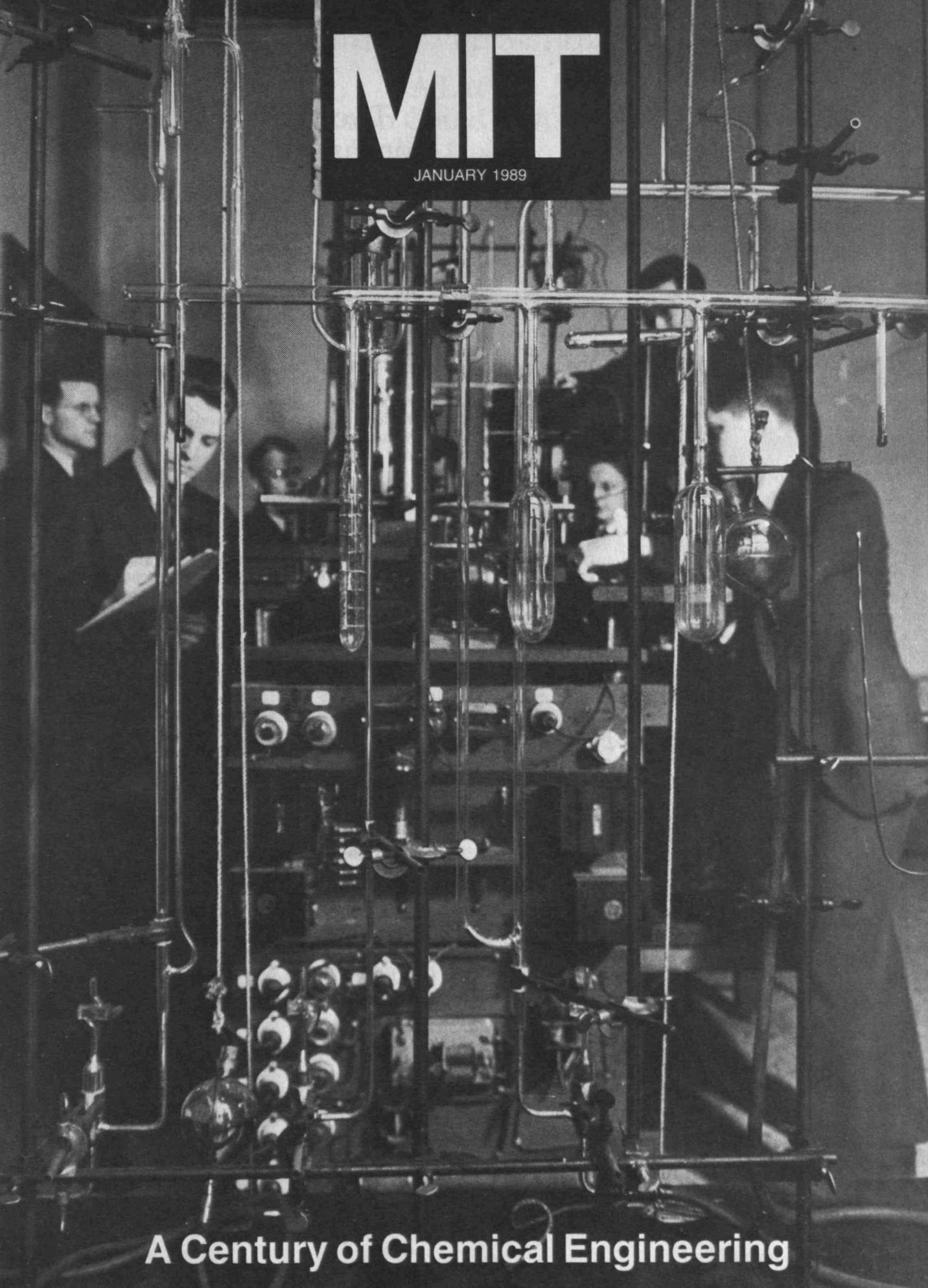
The Future of American Manufacturing

Lean production management certainly involves risks. Any hiccup will stop production completely since there are few inessential stocks, utility workers, or large repair areas to soften the impact of unexpected problems. But the potential gains are also great. Thus, lean operations can be considered high-risk/high-return ventures—although much of the risk can be neutralized by responsive suppliers, good product designs, and an experienced, well-trained work force.

The buffered production-management policy, on the other hand, is a safe bet for steady, if unexceptional, returns. It was appropriate for an era of stable markets and relatively little competition. However, just as the short-term risk is low, so too is the potential for long-term performance gain—a dangerous weakness in a highly competitive and fast-changing economic environment. ■

MIT

JANUARY 1989



A Century of Chemical Engineering

MIT

JANUARY 1989

WILLIAM RAWN, ARCHITECT FOR THE HUMAN CONDITION

COURSE X AT 100—CHEMICAL ENGINEERING CELEBRATES

PROJECT ATHENA, PART II: THE FACULTY AS SOFTWARE ENGINEERS

UNDER THE DOMES

Football Fever
Addresses by Gray, Wilson

ALUMNEWS

Class of 1948 Gathers
Association Awards

CAMPAIGN FOR THE FUTURE

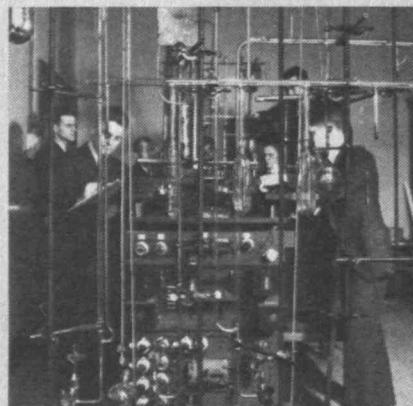
COURSES

CLASSES

Asian-American professor protests racism at UConn

OBITUARIES

PUZZLE



COVER

In 1937, when these students toiled in the labs in jackets and ties, Walter Whitman was beginning three decades as chairman of the relatively young Department of Chemical Engineering.

TEXTBOOKS AS REVENUE SOURCE FOR MIT

As an alumnus, I am concerned that if nothing drastic is done to contain the spiraling cost of an MIT education, MIT will price itself out of the market. Instead of depending on the help of alumnae/i and others, MIT should exploit its uniqueness to show the world what self-help can do.

After four years of working with Hewlett-Packard in Malaysia and Singapore and traveling in Asia, my first shock when I returned to the West was the exorbitant price of textbooks. Why do we need expensive hardcover texts when the technology today changes faster than the life of the book?

In Singapore, McGraw-Hill and other leading publishers sell high-quality, soft-cover editions of American textbooks for under US\$10. Books of comparable quality and price could be produced if the MIT Press organized a massive conversion of the teaching notes of MIT professors into textbooks.

If MIT is truly a leader, other colleges would eventually use our books. They could be translated into other languages and introduced to Tokyo, Peking, and other universities by MIT Press salespersons. Let the world learn about an evolving liberal education based on science from us. MIT texts could become the Sonys and Hondas of textbooks.

This program should slash the books and supplies portion of the student budget (about \$500 per year for undergraduates) in half. The profits from outside sales, after a percentage was returned to the faculty members, could be used to reduce tuition and room and board costs.

The MIT Press could also work with the Audio-Visual Department to package some of our more illustrious lectures for off-campus distribution.

YEE NING CHAN, '82
Nepean, Ontario

STATE OF RESEARCH EVEN WORSE THAN SOLOMON SAID

As Frank Solomon pointed out in his column (*October 1988, page MIT 3*), consensus thinking does have a diminishing effect on individuality. Further, I believe the problem is not confined to MIT; it is universal and is almost entirely a matter of economics and instinctive human behavior.

Most of the research I saw during my

Two Views on Publishing

time as a graduate student in biology (not at MIT) was boring, mindless, and redundant. The real objective of most science seemed to be feeding the researchers' need for acceptance and satisfying the requirements of granting agencies and tenure committees. Biology offers to society little solid return on its investment.

As a graduate student, I was constantly hearing how DNA and protein sequence data were the kind of "solid data that professors like." I concluded that sequence papers are some of the most tedious, least insightful works imaginable. If I were the head of a research group, I, too, would like to have an uncomplaining, dull-but-eager graduate student or postdoctoral fellow do that kind of work for me.

Watson and Crick opened the door for a lot of technicians to earn Ph.D.s and tenure. With proven sequencing methods readily available and with genomes being the size they are, the biologist who spends his or her time in the realm of ideas is bound to be outstripped in the competition for a job by the sheer volume of data a sequencer can amass in a short time.

We are living in a world where guarantees are becoming ever more important. If you just do everything "right," your job, research budget, retirement benefits, health insurance, life insurance, investments, and niche in the scientific community will never be threatened. As the availability of guarantees goes up, so does the relative risk faced by people who don't enjoy those guarantees.

Faced with a choice between a job candidate who is dull but low risk and another candidate whose work is more interesting but who might embarrass a department by being wrong on occasion, most departments hire the "safe" candidate.

LAWRENCE J. DUNN, '83
Fort Worth, Tex.

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A Little Confusion Could Be Just What We Need

In the October edition of *Technology Review*, biologist Frank Solomon made an eloquent argument for his view that research creativity is stifled when everyone on the faculty thinks he or she knows what is right. I'd like to make the point that undergraduate education is hobbled by the same attitude.

There's been considerable discussion in recent years about how we can make undergraduate education at MIT less of a grind, how we can make room for more self-directed learning, for appreciation of the social contexts of science and technology, for a whole array of topics and experiences that we don't address well, particularly in our beginning subjects.

We don't address these topics well not because we as a faculty don't care, but because we *do* care; we care so much about getting the curriculum right. When someone suggests adding, say, a design experience to a basic undergraduate subject, the response is, "What could we possibly leave out to make room for that? We have an enormous responsibility to cover the right curriculum as it is. There is no time to do anything else."

That drive to get it right feeds on itself until the education experience here becomes like Sergeant Joe Friday on the old *Dragnet* TV series. Everybody is anal compulsive and deeply concerned with time, and as soon as someone wants to do something interesting, they say, "Sorry, just the facts, please."

I'm optimistic, however, that this attitude will change—particularly at this time and particularly at MIT. The reason is that we are at the beginning of an intellectual revolution that is seriously confounding our notions of what should be covered in basic subjects in science and engineering. A consequence of this confusion is that we will be more free to open up our curriculum—precisely because we can no longer pretend that we know what is right.

HAROLD ABELSON is a professor of electrical engineering and computer science. This column is based on a talk he gave to the MIT Council on the Arts. Figure 2 is one of Barry Martin's "Mandalas," described in the "Computer Recreations" section of *Scientific American*, September 1986. The image of a nonlinear system as a swimming pool came from Professor Ralph Abraham of the University of California at Santa Cruz.

Figure 1

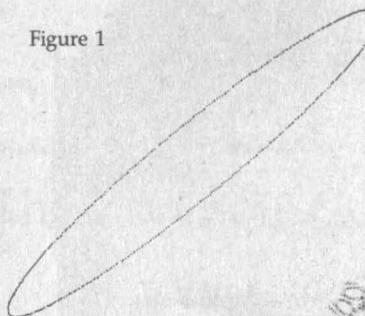
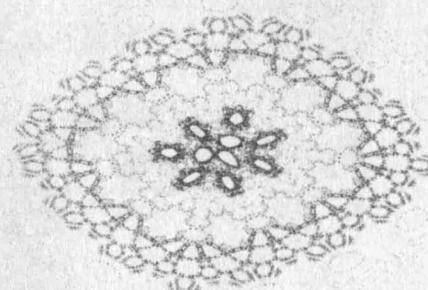


Figure 2



When we ask what in the present curriculum we can leave out to make room for more design and more creativity, we may find that we can leave out pretty much all of it. The topics we're now so anxious to cover will be regarded in much the way that we currently view drafting: some people will do it and find it valuable, but we won't claim that it's essential for everyone.

This kind of change can be seen in a subject that I am now teaching, **T** called systems, which is central to many areas of science and almost all branches of engineering. Systems is a beautiful confluence of mathematics and practical application. In electrical engineering, it deals with such things as how to process those noisy Mariner transmissions from Jupiter so you can see the images better, or how to design an audio amplifier so it has good frequency characteristics.

Until very recently, the only systems we even considered studying in our subjects were linear systems, for example, the vibrations of mechanical structures that behave like ideal springs or the response of electrical circuits composed of ideal resistors, capacitors, and inductors. For linear systems, there is a well-developed theory that leads to formulas that predict system responses with perfect precision. Figure 1 shows a typical example: Start with a point (x_1, y_1) in the plane and generate a sequence of points by

repeatedly applying the rule

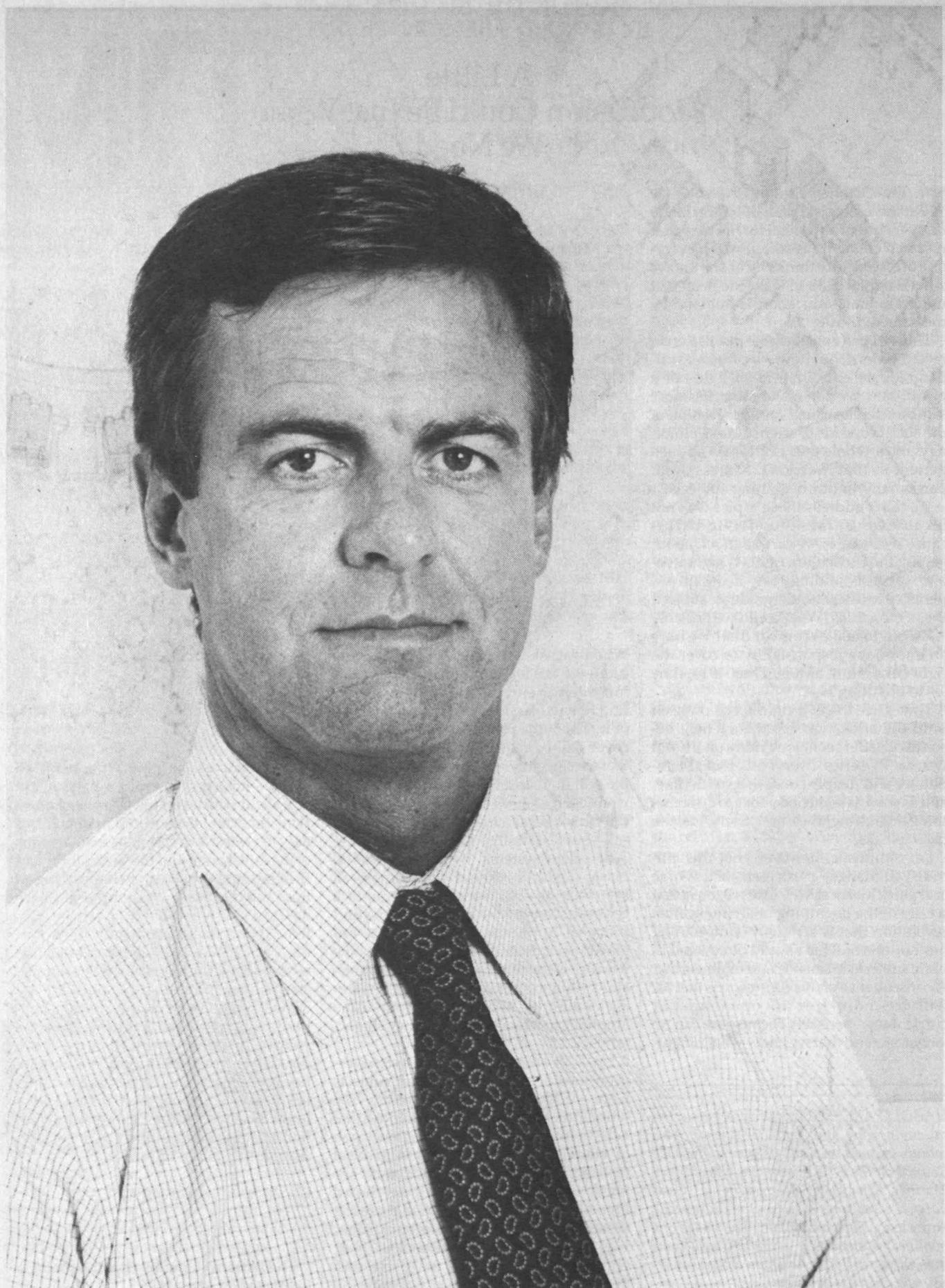
$$\begin{aligned}x_{n+1} &= y_n - Ax_n \\y_{n+1} &= B - x_n\end{aligned}$$

These successive points trace out an ellipse—not a very interesting pattern, but one about which you can ask a lot of questions that can be answered in detail. It is easy to write down formulas that, in terms of the initial point and the values for A and B, determine the size and shape of the ellipse and the rate at which the points trace it. This result is characteristic of linear systems: The evolving state of any linear system will trace out an easily described curve whose shape can be specified by a simple, closed-form formula.

Most phenomena, however—the vibrations of a clarinet reed, the buckling of a structural column under stress, the detailed motions of the planets, the behavior of electrical circuits with nonlinear elements—cannot be adequately treated as linear systems. Figure 2 shows the evolution of a system described by a transformation that is not linear:

$$\begin{aligned}x_{n+1} &= y_n - (\text{sign } x_n)\sqrt{|x_n - A|} \\y_{n+1} &= B - x_n\end{aligned}$$

The pattern of points, far from being a
Continued on page MIT 23



ARCHITECT WILLIAM RAWN



Architexture

Patterns That Promote Community

BY MICHAEL ERARD

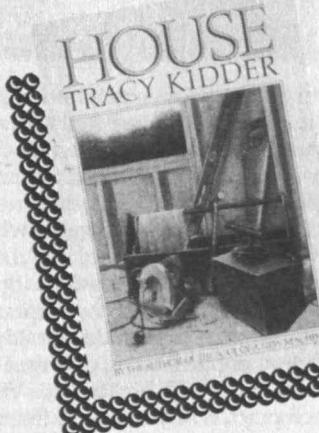
It is easy to imagine Boston architect William Rawn, M.Arch.'79, as a lawyer: he is articulate and expressive about architectural issues and his personal life in a manner that brings to mind a legal brief.

In fact, he did spend two years practicing law in New York City after attending Harvard Law School. But he had met architecture when he was a child, drawing houses and office buildings after school, and kept bumping into it later in life like a good friend. He specialized in housing, zoning, and land development in law school, wrote his thesis on housing programs, and did campus planning for the University of Massachusetts in Boston. It was not until 1975, at the age of 31, that he enrolled in M.I.T.'s School of Architecture and Planning and finally committed himself totally to the broader issues of American architectural design.

Outside the architectural community, Rawn may be best known as a leading player in Tracy Kidder's book *House*, which details the process of building a home for a family of four. Rawn designed a neo-Greek Revival house for his friends Jonathan and Judith Souweine that later won a 1985 Boston Export Award. It was his first independent project after he departed amicably from the architectural firm of Davis, Brody to open his own office in Boston.

"It's a total fluke," Rawn says, that within a month of starting his first project, a best-selling author wanted to do a book on it.

Michael Erard, now a junior at Williams College studying in Colombia, South America, was a summer intern at Technology Review.



Rawn's first independent project was well documented in this best-seller.

(Kidder was already well known for *Soul of A New Machine*, about the development of a new computer.) Rawn's firm opened in March 1983 and Kidder's book appeared in October 1985; in that time, Rawn avoided talking about the book, "because I didn't know what it was going to say."

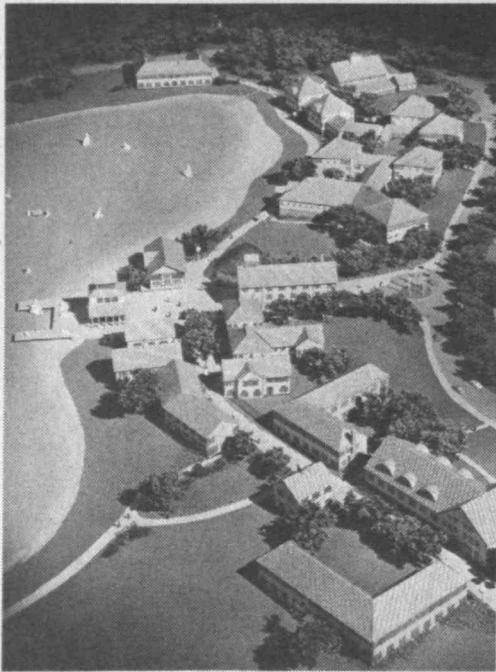
When it finally appeared, Rawn found *House* to be a faithful account of the project. The book illustrates the cooperation between people working toward a common goal—a house with integrity—and the tensions between their methods. The builders wanted to *craft* a house, not just build one; the Souweines' prime concern was getting a home for their family for a reasonable price and in a reasonable amount of time; and Rawn wanted to design more than "a machine for living." He wanted the design to fit into the context of the Souweines' lifestyle and into the architectural and historical landscape of

western Massachusetts—a house that is "contextual and post-modern," as Kidder describes it. In the end, everyone was satisfied, including Kidder, who has asked Rawn and Apple Corps, the builders in *House*, to design and build his own house.

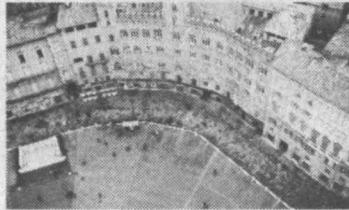
Despite the uncanny success of his first project, Rawn has designed only five single-family houses in the five years since beginning his firm. "I care so much more about broader urban and planning and building issues," he says. A wide variety of projects—some, like the affordable housing projects on Mission Hill in Boston and at the Charlestown Navy Yard, started before the book appeared—are now nearing completion. "We have a broad range of work. We didn't let the book suddenly limit our choices."

One of Rawn's priorities is designing buildings that promote community. He also likes to make sure that buildings fit into a larger theme. This is the "contextual and post-modern" designation by Kidder. Whether an affordable housing project, retail and office space, or campus additions, Rawn's perspective is both broad and thorough. Every building should be able to express its individuality while respecting the public realm in which it exists.

This awareness of pattern in a community becomes unconscious over time. "It's very much an intuitive thing," says Rawn, citing the growth of American farm towns. "There were no planning commissions, but people had some respect for the public realm. In New England towns, they'd build along the road in a proud but respectful way. They weren't trying to outdo their neighbors, but simply trying to build within a pattern."



To illustrate his ideas, Rawn draws on a collection of images that spans centuries. Ancient buildings in Siena, Italy (below) reflect the patterns of scale, fabric, and street edge that make communities comfortable. His design for a Massachusetts resort community features a meandering pedestrian path and commercial areas placed perpendicular to the waterfront.



Somewhere this pattern started to run amok and spatter America with overwrought shopping malls and planned communities on one hand, and incongruous city buildings on the other. Condominium developments from Florida to Massachusetts appear interchangeable, ignoring the character of the individual towns in which they are built. In his position as a member of the Boston Civic Design Commission, Rawn hopes to play a part in reversing and preventing similar situations in the Boston area.

Rawn's reaction to recent trends is not unique: according to the *Atlantic Monthly* (March 1988), "young designers and independent-minded developers" are being drawn to a "neo-traditional revolution out of disenchantment with the mess that Americans have made of their communities." Older and even more recent architecture is being labeled irresponsible; critics charge architects and builders with being more concerned with costs and personal gain than with the community as an aesthetic whole. The new public-oriented traditionalism is concerned with providing a "sense of place," a phrase which Rawn uses often when describing his projects.

When I talk about towns that I really like, I focus on four qualities. One is continuity of scale," Rawn says, pointing to a photograph of a town in the hills of Spain, in which the white-walled, red tile-roofed houses have very slight variations in size. Because he has traveled around the world and examined styles and forms, especially urban ones,

wherever he went, Rawn gets his inspiration from foreign forms as well as traditional American ones. Rawn pulls out slides from the Sahara, Ecuador, Spain, as if they were family pictures; he knows where they are and gets frustrated when he can't find a particular one.

"Another issue is the continuity of fabric." To illustrate this concept, he produces a photo of the arcade-like stretch of individual porches along one street in the town of Oak Bluffs on Martha's Vineyard. Each porch is "stylistically different," but the arcade pattern and the similar materials used in similar elements—a gable, a low overhang, bay windows, picket fences—unify the town.

"A third," he says, "is in terms of street edges, which in my mind are very public parts of a town." It is important, he says, that the street edge—"really a street wall, where the street comes up to the buildings"—be continuous. If buildings do not sit at similar distances from the street, the street edge is broken, which makes for an unbalanced pedestrian experience.

The fourth quality Rawn looks for relates to the way in which streets, especially commercial ones, attract people. In order to create a "vibrant commercial area," a street must present choices that will make people feel comfortable as pedestrians, residents, businesspersons, or shoppers. Rawn draws examples from Boston. For instance, Boylston Street around the Prudential Building "is very dead. You wouldn't go there to hang out." The spaces there are too open, the buildings set too far back from the street. On nearby New-

bury Street, he notes, the buildings on either side enclose pedestrians and provide a sense of balance. "Somehow, people like to shop where they can see something and cross the street."

Ultimately, Rawn says, "This neotraditionalism is important because it focuses on organization rather than the architecture of individual elements, so you could be effective building a very modern structure with the same traditional pattern." Houses as objects themselves are important, but so are the spaces that the houses form between them. "Space" is more than an area where there are no buildings; for Rawn, the space of an atrium, a street, a waterfront, or a town common is for community-building.

These qualities of pattern—scale, fabric, street edge, and street space—lead to community, Rawn believes. Not only do they work, but they have a tendency to maintain themselves, given a little attention. They have been combined in an extreme manner to produce the suburban phenomenon known as the shopping mall. Although the "sense of place" of a mall's interior is manufactured and manipulative, "the problem is that it has nothing to do with the broader town. Nothing from the bigger city can exist around it." The mall is isolated, of necessity, by acres of parking lots. Effective urban design combines both residential and commercial space in a dense center, which starts to break up towards the edges. "This gives people a choice," Rawn says.

Again and again in his different projects, Rawn returns to designs that allow for flexibility and individual choice, that avoid artifice and promote community. Rawn's proposal for a Lincoln, Mass., development achieves just this. The houses, similar to farm houses, are gathered around a town common, "extremely unconventional" by contemporary standards. Fortunately, the developer was "extremely supportive and the town is solidly behind it." Ordinarily, however, the marketing people are hard to convince. "It takes courage to tell them that they'll do better if they have something that respects the integrity of the town they're in," Rawn says.

Rawn and his fellow architects at William Rawn Associates were able to adapt lessons learned at the coastal resort town of Provincetown in their design for the Mt. Greylock site in western Massachusetts.



"My feeling about waterfront is that over the course of time in New England, people have built waterfront villages a certain way," he says. In responding to the shoreline, the New England main street either runs parallel or perpendicular to it. Rawn's Mt. Greylock resort proposal employs the parallel version, with the buildings facing each other and opening onto the street, to protect the citizens during the wintertime from the wind off a man-made lake. This evokes New England images of hearth and home, the warmth of the fire and coming together inside. "It's wonderfully cozy and warm."

In the summertime, however, when people want to get to the beach, the spaces perpendicular to the water between the buildings open up and the water comes much more into view. This harmonious response to public space, whether water or a public common, is a concern that Rawn shares with the neo-traditionalists. He finds waterfront and shoreline particularly important because they provide a sense of openness and escape but also a feeling of gathering. Water is thus a boundary and gives definition to the community.

College campuses, which should be close communities of minds and lives, need this definition as well. "One of our factors is continuing the pedestrian path that kind of meanders through the campus so that everyone gathers in spots. The whole campus life is on that path." The M.I.T. campus achieves this with the Infinite Corridor, which Rawn calls the "pedestrian spine" of the campus. While "you always know you'll bump into someone you know on that path," Rawn comments that "it's too rational. There's not enough choice and quirkiness on that spine."

Bill Rawn will say that for 600 years, architects have concerned themselves with both public and private life in a mutually beneficial way. The wisest ones have practiced "architecture for the human condition," architecture that responds to environment as well as experience.

Rawn's sense of history is more expansive than that of many other neo-traditional architects. He has extended his vision past the romanticized devotion to the myth of small-town America, past the grudging admission that people have to live and work in cities, and into the realization that cities are communities as well.

Continuity of scale, fabric, and street edge comes in American versions: elements from the Martha's Vineyard community of Oak Bluffs (below) are echoed in Rawn's own design for a development in Lincoln, Mass. In the Lincoln project, Rawn won support from the community for a plan that clusters houses around a town common.

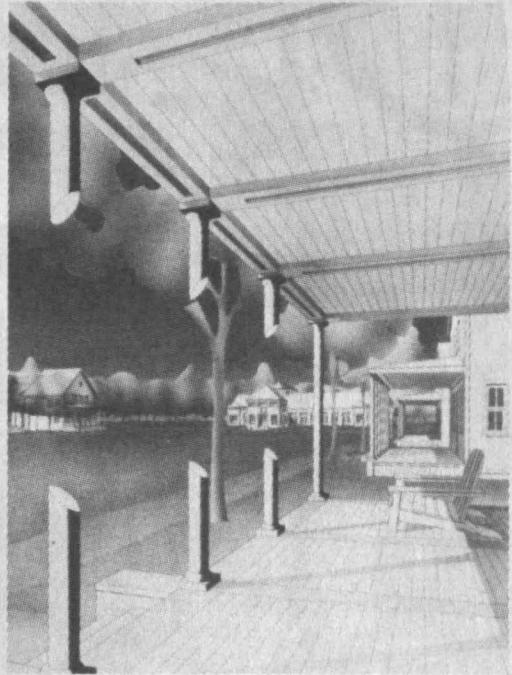


Rawn dots his conversations with references to cities that he knows. He can also cite a particular building from a city, draw it, explain it, put it into context.

For Rawn, American cities offer more than the security of a small town. Cities are dynamic, the marketplace of ideas, home of "relentless questioning" neither sustained nor tolerated by conventional rural wisdom. Unfortunately, Rawn says, cities are also battlegrounds, not only between intellectual forces, but between groups feeling the increasing pressures of population density and fighting for what remains of privilege and turf. Openness is the key: "If the city can't be open and if there can't be an interchange of ideas and people, then the city becomes oppressive.

"In America, the best cities offer incredible interchange of ideas. There is the dynamic that comes from lots of different people slightly rubbing shoulders, not embracing each other, not necessarily socializing . . . This involves designing buildings that open to the street, have a street facade, have a human scale that is visible from the outside, that don't separate different types of people." This "urban democracy," as Rawn calls it, is the ultimate community.

Rawn is a democrat: everyone, in his view, regardless of background, has aesthetic sensibilities of which an architect must be aware. His social conscience—particularly his awareness of the injustices of the cities—was really awakened at M.I.T. and led him to visit housing projects to understand what should be changed in their design. Rawn Associates has designed



three affordable housing projects and one mixed affordable and market rate housing project. Rawn's overarching continuity of design has extended to all these developments.

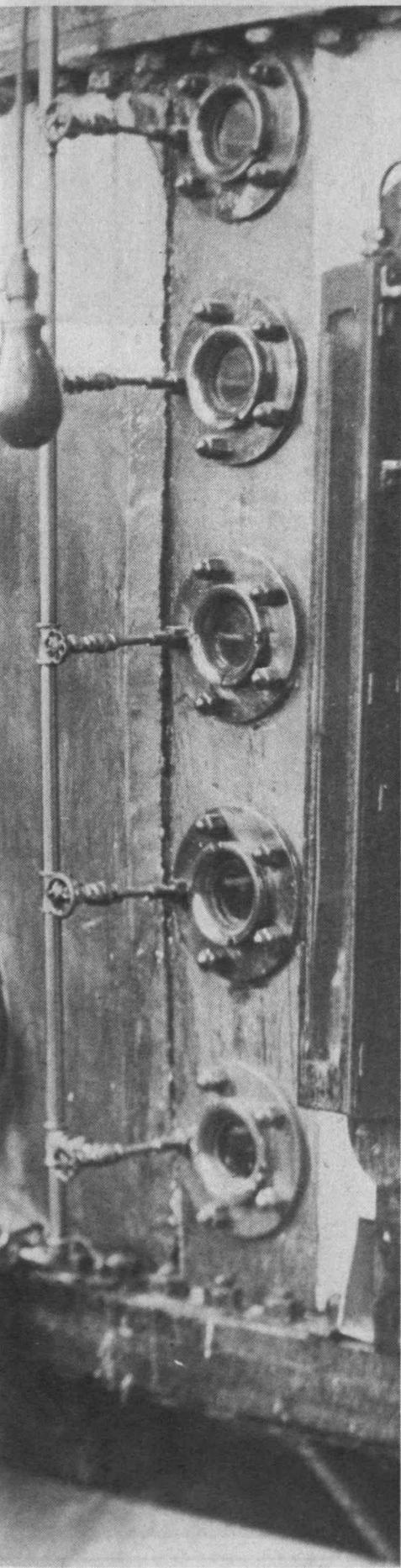
"My point now is that good urban design is actually cheaper." His block of row-houses in South Boston sold at cost and featured skylights and an open family/kitchen area. The front of the buildings were close to the street, which reduced the need for landscaping and brought sewer connections closer to the residences, further lowering costs.

"Architecture is very similar to writing, in that they are both pursuits that have to be viewed by the public," Rawn says. Once in the public domain, they have to be given up to an aesthetic public ownership. This means on one hand that the architect must be willing "to walk away from the design: if they want to paint the windows chartreuse, then you have to let them." On the other hand, it also means that the architect has become part of the community that takes root in and around his building.

Bill Rawn's life is all of a piece. The switch from law to architecture was "not a radical one because architecture was present in everything else anyway." The silk screen prints that he made between law and architecture school, groups of thin colored lines converging and opening up, fit into his style of architectural design. Even the well-publicized Souweine house has been put into perspective with a Yankee pithiness that wants to move on to other subjects. □



THE CHEMICAL ENGINEERING PRACTICE SCHOOL STATION NEAR BANGOR, MAINE, CIRCA 1920, PHOTO FROM THE MIT MUSEUM.



"Course X" Reaches the Century Mark

BY STEVE NADIS

MIT recently marked the 100th anniversary of a field it defined, developed, and dominated since the beginning: chemical engineering. More than 800 alumnae/i, faculty, students, and guests attended a series of talks, laboratory tours, and social events that celebrated the current research, the colorful history, and the challenges ahead for the field that MIT Management Dean Lester Thurow calls "a relative bright spot" on a discouraging industrial horizon.

It was one of the largest departmental reunions ever hosted at the Institute, according to Professor Clark Colton, Ph.D.'69, who organized the affair.

Chemical engineering was born at MIT in 1888, when Professor Lewis Norton, '76, proposed a new curriculum, "Course X," that would combine mechanical engineering with subjects in chemistry and laboratory work.

For the next several decades, MIT faculty developed the fundamental principles and made many of the early discoveries, participating in the birth and growth of the oil and chemical industries. Not surprisingly, MIT's biggest impact on the field came through education, says Department Head James Wei, Sc.D.'55: "We invented the field, we have written the basic textbooks, and we have educated two generations of leaders."

MIT's chemical engineering pioneers founded a profession that is responsible for much of the world's modern technological infrastructure. Industries dependent on chemical engineering now produce many of the materials from which

consumer products are made. Without chemical engineering, the petroleum, textile, and chemical manufacturing industries would not exist in their present form. Nor would it be possible to produce antibiotics, fertilizers, polymers, semiconductors, and synthetic fibers on a large scale.

MIT remains the leader in the field: it has the largest chemical engineering research faculty in the United States, and has led the nation in the granting of graduate degrees. More than 10 percent of the country's chemical engineering professors have earned one or more degrees at MIT. And more than 10 percent of the department's 6,000 living alumni are senior executives of industrial companies.

Professor Norton's earliest lectures described the commercial manufacture of chemicals used in industry. "The name Norton chose for the new curriculum was 'chemical engineering,' though it contained no course called chemical engineering and was taught by no one called a chemical engineer," explained Professor L.E. Scriven of the University of Minnesota, speaking at the Centennial's "Alumni Convocation."

Norton died in 1893, but the program continued under the tutelage of Professor Frank Thorp, '89, whose book, *Outlines of Industrial Chemistry*, was published in 1898. This hybrid quickly spread beyond the confines of MIT, and in 1892, a chemical engineering program was offered at the University of Pennsylvania. "So begins an acorn to grow," chemist Arthur D. Little, '85, reportedly said.

In 1902, William Walker, Little's partner in the consulting firm Little and Walker, accepted an appointment to join MIT's chemistry department and head Course

STEVE NADIS is a frequent contributor to Technology Review.

X. "Walker was poised, gentlemanly, an absolute master of the English language, and so strong in his convictions as to get himself in trouble," commented Professor Emeritus Hoyt Hottel, S.M. '24, speaking at the symposium on the early days.

Walker was concise, abrupt, and hated wasting time. "An engineer who plays a moderately good game of pool has used judgment; if he plays an excellent game, he has wasted his time," he often said.

Walker founded the Research Laboratory in Applied Chemistry (RLAC) in 1908, five years after Arthur Noyes founded the Research Laboratory of Physical Chemistry. Walker and Noyes were fierce rivals—Noyes favoring "pure" science, Walker favoring an applied approach. "They were two very able men, each so strong in his views as to have near contempt of the other," Hottel observed.

"Science by itself produces a badly deformed man who becomes rounded out to a useful, creative being only with great difficulty," Walker said. Noyes was equally critical about the value of teaching engineering.

As clashes between the two continued, MIT President Richard MacLaurin met with Walker one day and said, "Dr. Walker, I understand there is some friction in your department."

"Dr. MacLaurin, you are a physicist," Walker replied. "You know you cannot have motion without friction."

Little was not a member of the MIT faculty, but he took an increasing interest in chemical engineering education. In 1915, as chairman of the Visiting Committee, he recommended the establishment of the School of Chemical Engineering Practice, which was started the next year. Students in the "Practice School," as it came to be called, were able to conduct chemical engineering studies in actual industrial plants.

Little and Walker developed the concept of "unit operations," which provided a theoretical foundation for chemical engineering. The concept involved breaking down industrial chemical processes into a set of common basic operations—heat transfer, fluid flow, distillation, filtration, etc. Unit operations greatly simplified the study of diverse manufacturing processes.

During World War I, MIT chemists and chemical engineers responded to the threat posed by German chemical warfare capability. Noyes moved to Washington as chairman of the National Research Council. Walker became a colonel in the new Chemical Warfare Service, while Professor Warren Lewis, '05, headed one of the R&D divisions of the service. Professors William McAdams, '17, Robert Wilson, '16, Harold Weber, '18, and William Ryan, '18, all joined the military research effort.

Following the war, MIT reassembled its badly depleted chemical engineering staff. In 1920, Chemical Engineering—which had been housed in the Department of Chemistry since its inception—became a separate department, with Warren Lewis at the helm. In 1923, Walker, Lewis, and McAdams produced the so-called Course X Bible, *Principles of Chemical Engineering*, the first textbook that shaped the discipline and helped define the profession.

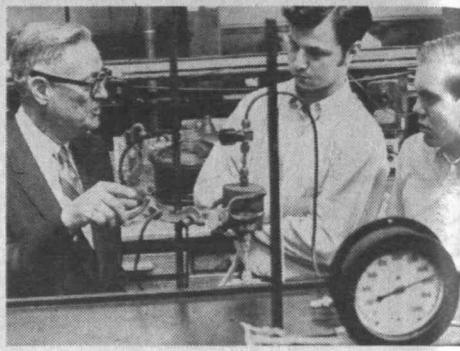
"Walker was Lewis's idol, and that word was not an exaggeration," Hottel commented. "Lewis was a much better engineer, but in the twenties, in comparison to Walker, he considered himself an 'awkward country boy.'"

Lewis's approach differed from that of Walker's, according to Ralph Landau, Sc.D.'41, of Listowel Inc., who also spoke at the symposium. "Rather than bringing industry to campus, he brought the campus to industry," Landau said. "Lewis created the precedent that able MIT faculty and students should go into industry and move it along. Unlike the Practice School, which merely exposed students to various industrial practices, Lewis encouraged MIT's top experts to go out and solve the big problems in industry."

In the 1920s, the explosive growth in the use of automobiles led to unprecedented demand for gasoline. New methods of petroleum refining were needed, and oil companies hired large numbers of MIT chemical engineers, who dominated the industry for years. Under Lewis's guidance, chemical engineering focused on the design of continuous, automated processing of a wide variety of products—first in petroleum refining, and then in chemicals. Lewis himself, along with Professor Edwin Gilliland, '33, developed the fluidized-bed method for the catalytic cracking of petroleum—a technique that revolutionized the way gasoline was produced.

Herman Meissner, '29, now professor emeritus, arrived as a freshman chemical engineering student in 1925. "I came for the same reasons a good many of my classmates did—I liked to carry out chemistry experiments at home, successfully, without blowing off any fingers," Meissner said during his Centennial reminiscences. Meissner was attracted by the enormous reputation of the department, and "the man primarily responsible for that reputation was W.K. Lewis," he said.

Lewis had four attributes critical for academic leadership, according to Meissner. First, he had a reputation and a record of accomplishment. Second, he knew where he wanted the profession to go. Third, he surrounded himself with an extremely capable staff. Fourth, he was a skilled communicator. "[Those qualities] make me think of what we are looking for in our nat-



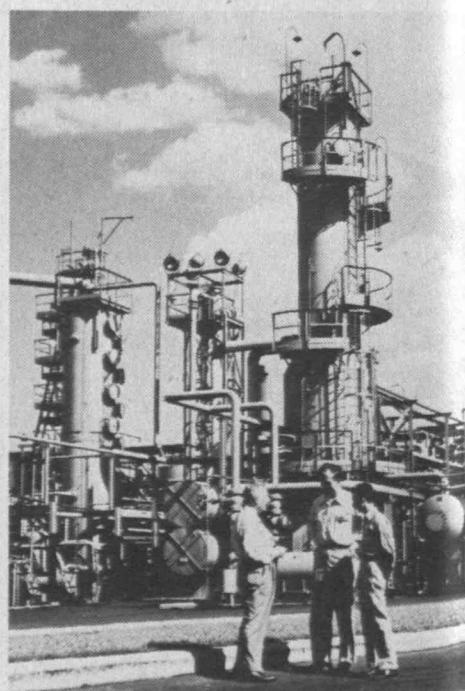
(1) A text on distillation by Edwin Gilliland, '33, proved popular with Prohibition bootleggers.

(2) A researcher in the RLAC treating a tablecloth stained with plum in a scientific study of laundry processes.

(3) Chemical engineering student in the Boston lab, circa 1890.

(4) Warren Lewis, '05, was an inspiring teacher as well as a guiding force in the department.

(5) Lewis (left) conferring with staff at the Bayway Practice Station.





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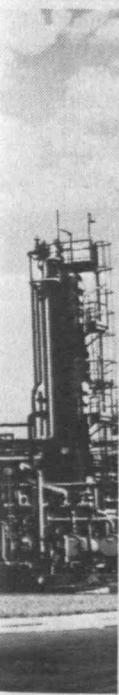


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Fierce rivals Arthur Noyes (left) and William Walker (above) kept the sparks flying in the debate between pure and applied science.

tional leadership at the present time," Meissner said.

Referring to Lewis's associates, Meissner added, "I don't think an equal assemblage of stars has existed since. . . ." Edwin Gilliland, for example, co-wrote a classic work on distillation that was used not only by engineers, but also by bootleggers during Prohibition. "In my long life, I have met a great many people, even Nobel Laureates," Meissner said. "Ed comes close to heading that list in terms of capacity." Just as important, Gilliland "had a quality of sweetness. He was a nice guy."

Meissner also talked about William McAdams (who published the classic text, *Heat Transmission*, in 1933): "a workaholic who certainly liked to verbalize his thinking. He talked all the time; he liked to have his assistant standing by and when necessary, make inputs. It was an arduous business, but very educational. Mac loved parties, and he loved to sing, accompanying himself on the guitar. He would have made a good stand-in for the Peter, Paul, and Mary group, except for the circumstances of their politics."

Also in Lewis's group was Thomas Sherwood, Sc.D.'24, the pioneer in mass transfer who wrote the 1937 text, *Adsorption and Extraction*, as well as co-writing *Applied Mathematics in Chemical Engineering* with Charles Reed, '37, in 1939. "He was a man of many talents, ranging from oil painting to mountain climbing, if you can call that a talent. It may be madness," said Meissner. "[Sherwood] was remarkable because he kept the neatest desk that I have ever seen at the Institute.

Walter Whitman headed the department for roughly three decades starting in 1933, the longest tenure in the department's history. Whitman, '17, according to Meissner, was "a born diplomat. And he needed all his diplomacy to run his stable of academics who did not take lightly to too much direction."

In addition to attracting outstanding associates, Lewis was also an outstanding teacher himself. "He proceeded through a brilliantly formulated series of questions, which developed the points he wanted to make beautifully," Meissner said, "All of us thought he was a direct descendent of Socrates."

Ralph Landau—for whom the department's building is now named—lauded the continuing excellence maintained by today's faculty. He ended with "a salute to my greatest teacher, a man who probably had more to do with our industry than any other individual, the real founder of our profession, Warren K. Lewis. But I would be remiss if I didn't say the chemical engineering department of MIT is once again in the same leadership position it was in the 40s and 50s."



Ralph Landau, Sc.D. '41, and James Wei, Sc.D.'55, head of the department.



Jennifer Smith, '87, spoke at the Alumni Convocation.



Labs today bear little resemblance to the crockery- and glass-filled labs 100 years ago.



Joe Moore, '52, Gary Falkenstein, '59, and Samuel Bodman, Ph.D.'65.

Sharing anecdotes about a singularly successful history was great fun, but the Centennial's colloquy was equally concerned with where we go from here. In his talk about "Future Directions in Chemical Engineering," Professor Wei noted the great achievements in the last century, but also warned about "storm clouds on the horizon." Wei was recently on an MIT commission that studied the productivity and competitiveness of American industry, specifically addressing the question, "Why is America no longer making things the rest of the world wants to buy?"

"We found the good news is that the chemical industry is one of the most successful industries today," Wei said. Productivity in the chemical industry is more than five times the national average. Last year the industry had an \$11 billion surplus of exports over imports. "I am tempted to say that this is because the chemical industry is managed by chemical engineers who have superior brains, excellent education, and good looks," Wei quipped.

MIT School of Management Dean Lester Thurow, who also spoke at the convocation, attributes the success of the chemical industry to the fact that "it's one of the few industries in the U.S. in which technical people tend to come to the top. Almost all the CEOs with Ph.D.s [in the United States] are in pharmaceuticals or chemicals." Despite the relative success of the chemical industry in the nation's economy, "we can do better," Thurow said.

Another speaker, Samuel Bodman, Sc.D.'65, president of the Cabot Corporation, explained that during the 1930s, 40s, and 50s, "chemical engineering was the most entrepreneurial of the engineering disciplines." Lately, however, the giant companies such as Union Carbide, Firestone, Gulf Oil, Conoco, Texaco, Borg Warner, and U.S. Steel have proved resistant to change. "These great companies either have not survived or are carrying on in a much weakened condition," Bodman said.

As a young MIT faculty member in the 1960s, Bodman recalls Ed Gilliland and Tom Sherwood telling him that "the pioneers in the field signed on because they believed they had the capacity to remake the commercial world in a very fundamental way." They predicted that synthetic materials such as polymers and composites would replace the standard construction materials—wood, steel, and aluminum. "Much was accomplished, but much of that optimism was not fully realized."

Bodman was not alone in asking how we should change the nature of our academic enterprise so that the institutions of the next century will fare better in an in-

creasingly international, competitive, and complex marketplace.

For two days prior to the symposium, 35 of the leading researchers and educators in the field came to MIT to discuss that very question. One area of agreement, Wei said, was that "we don't have all the tools we need. To get into biotechnology, we need to understand biochemistry, genetics, polymer chemistry, solid-state chemistry, and many subjects that are not in our discipline." And that's the rub.

As chemical engineering turns to frontiers such as bioengineering, microelectronics, computer-aided engineering, and advanced materials science, "there is increasing demand to put more and more material in our curriculum," Wei acknowledged. "People say, how can you turn out a chemical engineer who doesn't know quantum mechanics, molecular biology, computer languages, foreign languages, environmental and social concerns, and ethics? But, you know, an MIT education is like drinking from a firehose. Is it time to increase the pressure on the firehose? How do you put more material in and still get through in four years, and still have time to [do all the normal human things like] watch Red Sox games, drink beer in the dorms, make friendships, and grow as individuals?"

Wei suggests we "put aside the pretense that we can really turn out a professional engineer in the four years of college. (See *UNDER THE DOMES* for comments of the Dean of Engineering. —Ed.) The truth is, we have never done that. Engineering has always been a partnership between universities and industry. Universities teach them the fundamentals, then the graduates enter industry as apprentices. This is really no different from medical education, where the internships are done in hospitals and clinics. Of course, this is also the concept of the Practice School."

Bodman believes there is substantial room for improvement in graduate-level education. "We are producing players who are entering a game they are ill-equipped to compete in effectively," he says. Graduate students in chemical engineering should be required to learn a foreign language, study global economics, marketing strategies, and patent law. All this can be done, he stresses, without sacrificing technical excellence.

Wei is optimistic, so long as chemical engineers continue to do the things that have made them successful in the past—if we "keep educating ourselves, keep doing our homework, and keep preparing ourselves for the future."

"Doc Lewis used to tell us that a chemical engineer can do anything. And, of course, with him staring down at us, we had to agree." □



MIT Faculty Learning How to Teach with New Tools

BY SIMSON L. GARFINKEL, '87

In a darkened lecture hall, a professor stands before a class of sophomore aeronautics and astronautics majors and types a few commands into an Athena workstation. Moments later a cross section of an airplane's wing (airfoil) appears on a 12-foot silver screen at the front of the classroom. A row of animated bubbles materialize in front of the wing and move across it, showing the path that air would take if the "wing" were really "flying."

"If you have a picture of a fluid flowing, and nothing very exciting seems to be [going on], what happens if you change the angle of attack of the wing?" asks James McCune, the professor in question. "What happens to [a particular] fluid particle? Does it go on top of the wing, does it go under, does it get caught in the wake? Does it exert lift?"

Lift, McCune says, is caused when air moves faster over the top of the wing than underneath it. The faster the air moves, the lower the pressure. The drop in pressure holds the airplane in the sky like a suction pump.

Only two years ago McCune might have been showing a film on lift to his class. But unlike a film, the computer can be manipulated by McCune: with just a few movements of the "mouse" at the side of the workstation he can change the simulated system. He can also turn it over to the class: One student asks him to try a different angle of attack; another wants to see what happens when the wing "moves" faster through the simulated fluid. The class comes alive, each student suggesting another possibility.

At the end of the hour, each student can go off to one of 33 Athena clusters located around campus, sit down at a workstation, and try different variations on

the problem until he or she has developed an intuitive grasp of the concept of lift.

"You're more interested if you have to make the choices," says Professor Earll M. Murman, Athena's new director. "Being given a book of pictures or a videotape is just not the same."

On the fifth floor of Building 9 is another face of the goddess. In a glass-walled room called simply "The Garden," a collection of IBM PC/AT computers, graphics screens, digitizing tablets, and a few workstations have sprouted as a result of the five-year-old collaboration between MIT, IBM, and Digital Equipment Corp. Here students in the School of Architecture and Planning use largely off-the-shelf software for drafting, building spreadsheets, and word processing.

"This idea of gluing together [commercial] application tools rather than building one [custom] package that can 'do it all' is the focus of what I have been trying to do," says Professor Joseph Ferreira, '67. Ferreira has been the driving force for this outpost of Athena.

"For planners," Ferreira says, "the time frame you have to construct a model and do a lot of 'what-if' calculations is pretty short. The spreadsheets are ideal for desktop modeling." In the Garden, the School of Architecture and Planning's students learn to use software packages similar to those they will encounter as working professionals.

Across MIT, Athena is changing the way subjects are taught and ideas are conveyed, from freshman seminars on physics to graduate classes on transportation. The real success stories of Project Athena have been programs that students can use as tools to help them solve problems.

The airfoil program is an example of such a tool. "It's a flexible electronic simulation," says Murman, who spent five

years coordinating the development of the system. The "tool" is really a collection of seven tools, which examine aspects of fluid dynamics from jet nozzle design to thermodynamics. A different faculty member oversaw the development of each module; collectively they are bundled together in a package called "Todor," named for the great Hungarian aeronautical engineer, Theodore von Karman.

Murman characterizes Todor as coming about by accident, not by design. "It just happened," he says. But in fact, his department's commitment of time and attention makes this more than a fortuitous accident. In 1983 12 professors in the department took a two-day sabbatical at MIT's Endicott House. Their agenda was to think of ways of using new media to reach students—particularly those for whom subjects like fluid dynamics can be a struggle.

"At the end of that retreat, we had narrowed [the uses for computers] to seven project objectives." And by the end of 1985, each faculty member had developed a module. When they found an approach that worked, Murman says, it was put into the system.

Similar to Todor is the Department of Civil Engineering's program GROWLTIGER, which enables students to "build" structures, such as buildings and bridges, on the computer's screen and analyze the forces on them. The program can tell a student which buildings will stand and which will fall: like Todor, it is an electronic laboratory. But unlike Todor, GROWLTIGER was written by one person, John Slater, '78.

(Slater now works at Stone & Webster, a Boston engineering firm founded by MIT graduates and involved in construction of MIT's Cambridge site. But from 1982 until last spring, he was a professor of civil engineering.)

Slater spent a thousand hours between

SIMSON GARFINKEL is a freelance writer based in Somerville, Mass.

Now you can graph differential equations on a screen. No more tables!

March and September in 1984 writing the first version of the system. GROWLTIGER now contains more than 80,000 lines of code and, like Todor, can be run from most of the workstations at the Institute.

"A student can sit down for two hours, learn it, and actually be productive," Slater says. The system is powerful enough to help both undergraduate and graduate students solve problems, he adds.

After teaching himself C in order to write GROWLTIGER, Slater introduced C as a programming language to 1.00 (Introduction to Computers and Engineering Problem Solving) in fall 1985. He reports that when C, which was seen as the language of the future, replaced FORTRAN in

time lab in "Observational Techniques of Optical Astronomy," a subject jointly offered by Course XII and Physics (Course VIII).

Since September 1986, students taking 18.03 (Differential Equations) have used another tool-like program to graph differential equations. The program replaces the time-consuming task of plotting differential equations by plugging numbers into a calculator and writing down the results. "When the calculator solved the differential equations, you got tables," says Professor Arthur Mattuck, who teaches the subject and supervised the development of the program. "That was totally unacceptable for teaching."

past them. Another program allows students to see how a clock sent to Alpha Centauri would tick slower than a clock left behind on Earth, explains Edwin Taylor, a senior researcher who supervised the project.

A Few Flies in the Ointment

When it announced Project Athena in 1983, MIT stated that the people who would write the next generation of educational software would come from within the Institute faculty and student community. While Athena did hire a technical staff, that staff's primary purpose was to develop the underlying operating system.

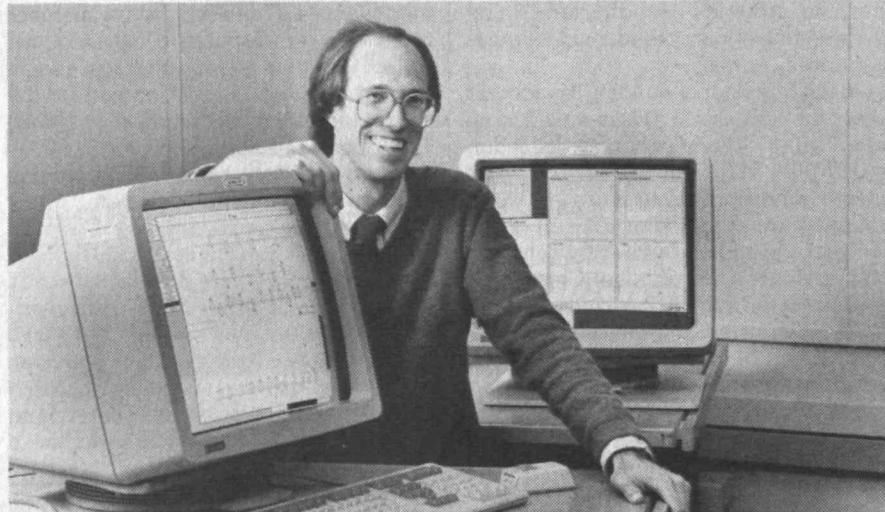
In many cases that proved a workable system. The Todor program, for example, was the combined work of 39 students, nearly all of them undergraduates, 14 professors, and only two full-time programmers. But many projects outside of the School of Engineering have not been so fortunate.

Although Professor William K. Durfee teaches in the Department of Mechanical Engineering, he also harbors a passion for the theater. Since September 1986 he has been supervising the development of a program on Athena to help designers plan the placement of lights in theater productions.

"The creative part ends when you have a visual picture of what the stage should look like," Durfee says. "After that . . . it's all grunt work." Durfee estimates that without a computer, more than 80 percent of a designer's time is taken up by drafting lighting plans.

Durfee's biggest headache on the Athena project has been finding students who both know the subject material and are capable of writing the software. At first, Durfee worked with students who knew a lot about theater design. "They [would] spend most of their time learning how to program." Turning to computer hackers wasn't any better, because they had to be taught the ins and outs of the theater from the ground up. Eventually, he says, he "found a couple of people who are theater people and Unix techies, but that mix is really hard to find." (Unix is the Athena operating system.)

Durfee's frustration has been shared by many across the Institute. One of the subtle ironies of the computer age, it seems, is that it is very difficult to write a program that is easy to use. Although Project Athena's X-Windows system made it possible



Mechanical Engineering Professor William K. Durfee has found that Athena can take most of the grunt work out of designing the lighting for theater productions.

the class, enrollment grew from 85 to 260 students within a few years. "That's a real impact."

Athena's projects in the School of Science have tended towards small programs that let students solve specific problems, rather than the large-scale electronic laboratories like GROWLTIGER and Todor. Graduate students in the Department of Earth, Atmospheric and Planetary Sciences (Course XII) adapted a publicly available program called STARCHART to the Athena system. STARCHART, says James Klavetter, a graduate student in the department, displays on the computer's screen a picture of the night sky. The chart can then be printed and carried by students up to the roof of the Green Building for the night-

freshmen can't handle tables of data."

"Now there is no data; the output is a curve on the screen," Mattuck says. "Instead of an exact answer—that often teaches you nothing—the graph gives you qualitative information. Does the solution increase, take off, or go to zero? How does it behave?" By typing a few numbers into the workstation, students can find out.

A project in the Department of Physics gives students an opportunity to observe the effects of relativity. VISUAL APPEARANCE presents students with the view from the front window of a simulated spaceship traveling near the speed of light. Objects on the computer's screen seem to distort and change in color—from purple to blue, light blue, green, and finally red—as the spacecraft accelerates and moves

MIT hoped to export Athena software, but that is almost impossible in some subjects.

to write programs that could exploit the graphics capabilities of the workstation, X-Windows didn't make it easy.

Unlike good teachers, who are priceless, software can be copied and sold relatively easily. One of the early hopes for Project Athena was that the programs developed at MIT could be transported to other universities and make a significant impact on American education. For some projects this hope has been realized: Last summer professors from 19 schools, predominantly teaching colleges, participated at an NSF-sponsored workshop at MIT where they learned about Course XVI's Todor program. Everybody who came got a copy of the software, reports Murman. Everybody who came could run the software, too, because one of the requirements of attendance was having access to advanced workstations.

Programs that run on IBM personal computers have also been distributed. Working with funds from both Project Athena and the International Masonry Institute, Professor Eric J. Dluhosch oversaw the development of a program that lets students draw a building and calculate how much it will cost. That program is being distributed to every school of architecture in the United States, Dluhosch says. The packages come complete with a video disc that can show students photographs of buildings similar to the one they are designing.

But in other cases, Athena's choice of high-performance workstations has limited the distribution of the software produced here. In the Department of Political Science, Professor Hayward Alker has overseen the development of a program enabling students to analyze arguments and a game simulating the impact of the international arms buildup on negotiations of war and peace.

"The biggest problem for its [dissemination] is not its specificity to one course," Alker says. The problem is that "it's written in Unix and in C for relatively powerful professional workstations." Social scientists at schools like Wisconsin, Chicago, and North Carolina—a logical market for this software—use the MS DOS operating system that comes standard with IBM personal computers, according to Alker. Even at many universities that have high-performance workstations, access to these machines is restricted to the engineering and science departments.

Alker's concern with portability is mild compared with that of at least one of his

MIT colleagues:

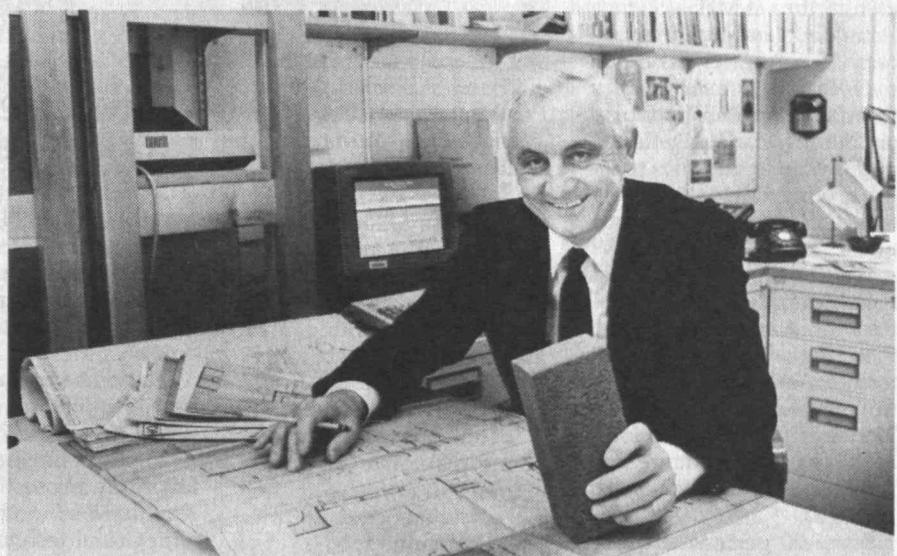
"The workstations are totally useless, in the sense that if you write programs for them, nobody else in the world can use them," says Edwin Taylor in the Physics Department. Taylor says he feels "ambivalent" about Athena: while the project provided \$165,000 to fund his release time and hire programmers for the relativity programs, it also dictated what kind of computers he had to write them for. Indeed, Taylor's request for additional funds for his Athena project was rejected: he wanted to write programs for IBM PCs and Apple Macintosh computers instead of Athena-sanctioned workstations.

"I'm not going to spend all this time to

tells them how close they are to correct pronunciation.

A second phase of the project will use artificial intelligence to allow the students to carry on text-based conversations with imaginary characters in the machine in Spanish, French, German, or Russian.

And the third section is a pair of video discs designed to help students learn French and Spanish. The first disc starts with a game in which students help a Frenchman named Philippe to either make up with his girlfriend or find a new apartment in Paris. "It's a modern difficulty," Murray explains. "On the other side [of the disc], the student can explore a neighborhood in Paris and listen to a var-



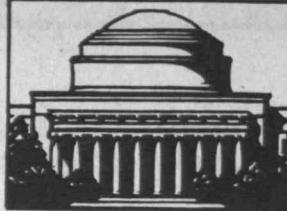
Architecture students nationwide now have a program that lets them draw a building and calculate its cost, thanks in part to Professor Eric J. Dluhosch.

write programs that can only be used at MIT," Taylor says. "It's like doing research where the results can only be reported at MIT."

Some of the most exciting projects are still a year or more from deployment in the classroom. One of the more ambitious is the Athena Language Learning Project, under the direction of Janet H. Murray, principal research scientist in the MIT Writing Program. The project really consists of three independent sections: one section, designed to help non-native students learn English, will use digital voice processing to "display spectrograms of student utterances and allows them to check their pronunciation of key phonemes against the ideal pronunciation," Murray says. They get a visual signal that

ity of people . . . talk about their lives, professions, and neighborhood." In the second disk, called *No recuerdo* (Spanish for "I don't remember"), a student plays the role of someone who meets a doctor from Colombia who is suffering from amnesia. The student must talk to the doctor and help him to regain his memory before a disaster occurs.

With two and a half years remaining for Project Athena, there's still plenty of room for the development of brand-new applications, as well as the completion of others in the pipeline. In the next article, we'll see what impact these programs and the 722 workstations scattered about the campus and in the living groups have had on their intended targets: the MIT student body. □



UNDER THE DOMES

Corporate Real-Estate Portfolios Neglected

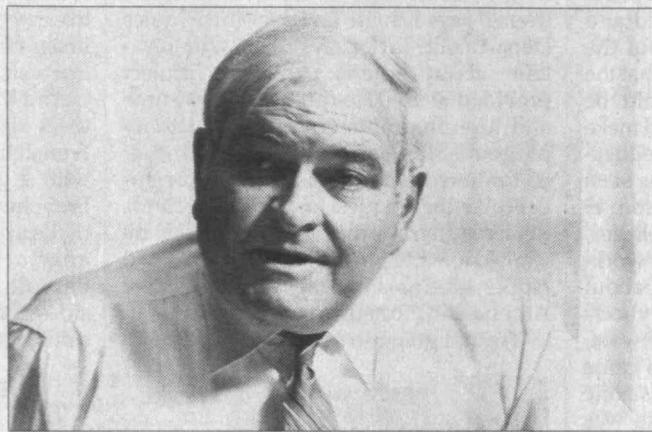
Most corporations manage their real-estate holdings very badly—if at all, says Peter R. Veale, a graduate student in architecture at MIT.

Buildings and land are typically 25 percent of a company's tangible assets. But there's no established discipline for managing them, and many company real-estate officers lack even inventories of what the company owns.

Veale's data, published early last summer by the Laboratory of Architecture and Planning at M.I.T., results from an in-depth survey of senior real-estate executives at 284 large U.S. corporations and institutions that are not primarily in the real-estate business.

Some 90 percent of these organizations assured Veale that they had organized real-estate management units. But when he queried these units, Veale found a very fuzzy picture. One in four lacked an inventory of company holdings. Two out of three had no computerized real-estate management information systems. One in four didn't know the market value of the organization's real-estate portfolio, and one in three didn't know the original acquisition cost. In only 30 percent of the companies was real-estate information reported to senior management on a scheduled basis.

Indeed, says Veale, real-



President Paul E. Gray, '54, addressed the National Academy of Engineering.

estate is a forgotten stepchild throughout the management profession. Though they claim to offer "strategic and progressive consulting in all management dimensions," reports Veale, 37 top consulting firms admitted to him that "consulting services for corporate real-estate are never offered." In fact, the field of real estate management was never mentioned.

Furthermore, says Veale, no business school in the United States today has classes in such fields as real estate, facilities, space, buildings, or land management.

Veale's study, which attracted the attention of the *Wall Street Journal* and other professional publications, was actually a master's thesis carried out under the supervision of Architecture Professor Ranko Bon and Michael Joroff, director of the Laboratory of Architecture and Planning. It was sponsored by Shimizu Corp. of Japan as part of an overall study of the management of real estate in the United States and Japan. □

tal alternative to fossil-fueled plants, which contribute to atmospheric carbon dioxide and therefore to "greenhouse" warming of the atmosphere. He highlighted the potential advantages offered by small (100-150 megawatts), "passively safe" reactors, combined on site to provide necessary power.

Engineers have professional responsibility, said Gray, "to consider the full consequences of any innovation. . . . It is professionally and morally irresponsible to define a problem so narrowly as to leave these considerations to others."

To those who, like himself, are training future engineers, Gray had three suggestions:

- Help students who are interested in the interface between technology and society become what Gray called "interface engineers," specialists in the "political, economic, and social issues that are integral to scientific and technological developments."
- Use problems "that are not artificially isolated from their social context" to teach engineering design.
- Prepare all students to reach solutions "that are both socially responsible and firmly grounded in technical realities."
- And while they're teaching, Gray said, his engineering education colleagues should also be tackling research on "technology for sustainable development, appropriate allocation of resources, and risk management." □

"Interface Engineers"

The mixed blessing of almost every technology development," says MIT President Paul E. Gray, '54, is "a paradox of our times."

Examples abound. To illustrate his point in a major address to the National Academy of Engineering last fall, Gray chose the "green revolution"—the changes in agricultural technology that have vastly increased world food production, especially in the developing countries. With it has come unwanted dependence on fertilizers and insecticides, "threatening the food chain itself," said Gray.

There have been many instances where we deliberately ignored the potential for adverse, sometimes irreversible side effects. But too often the adverse effects are unpredictable. And even when we confront unwanted side effects, we cannot agree on how to weigh the benefits of technology against its cost.

Hence the present stalemate on nuclear power, which Gray believes is a vi-

For a copy of the full text of President Gray's address, write to William Hecht, executive vice-president, Association of MIT Alumni and Alumnae.

MIT Football: Life in the Spotlight

Pre-eminent local sports-caster Bob Lobel of WBZ-TV had just finished an interview with MIT football co-captain Mark Naugle, '90. Lobel made a casual remark about Phi Gamma Delta fraternity, and Naugle spun around.

"You're a Fiji!" Naugle exclaimed. "No way!"

"Sure," Lobel replied. "I've got the tattoo to prove it. I'll show you when we're done."

Naugle threw himself on the ground and stripped off his cleat, sock, and ankle tape to expose his tattoo. When Lobel finished the next interview, he casually reached down, pulled down his sock, and he and Naugle compared their Fiji "marks of honor."

Naugle thought the fact that he and Lobel were fraternity brothers was amazing. What was even more amazing was the fact that Lobel was at the Institute to cover a story about football in the first place. Even more astounding than that is the fact that media from all over the country converged on the Institute by car, plane, train, and phone simply because MIT had returned to varsity football for the first time in 87 years.

Last May, the Athletic Board at MIT approved a change in the status of football at the Institute from a club sport to National Collegiate Athletic Association (NCAA) Division III.

"It's really not a big deal," coach Dwight Smith commented. "We've been playing good, competitive football

since 1978. We'll be playing mostly the same teams, and there won't be any difference from the way we've been doing things in the past."

Members of the media saw the situation differently.

In June a simple press release about the elevation in status of MIT football was sent to the *Boston Globe*, *Boston Herald*, Associated Press, United Press International, *USA Today*, and the *New York Times*. The *Globe* ran a headline in the next day's edition in the "College Notebook" column, and very little was heard or mentioned about the move until mid-August.

Then Malcolm Moran, a sportswriter for the *Times*, spent a day at the Institute, attending pre-season practice and talking to the coaches and players. Several days later his article appeared on the front page of the sports section of the *Times* headlined "Football, For Real, at MIT," with a photo.

If there are people who doubt that the *New York Times* is still a trendsetter among the media, they don't work in the MIT Department of Athletics. Once the *Times* article hit the newsstands, the MIT Sports Information Office was inundated with phone calls from television stations, radio stations, and newspapers.

USA Today was next in print, with an above-the-fold, center-page, five-column story which in part compared the size of the MIT players and playbook to those of Notre Dame. That story was printed the Thursday before the first game, which also happened to be the day that both ABC and CBS Sports called, wanting to do reports during the halftime shows on

their Saturday afternoon national college football telecasts.

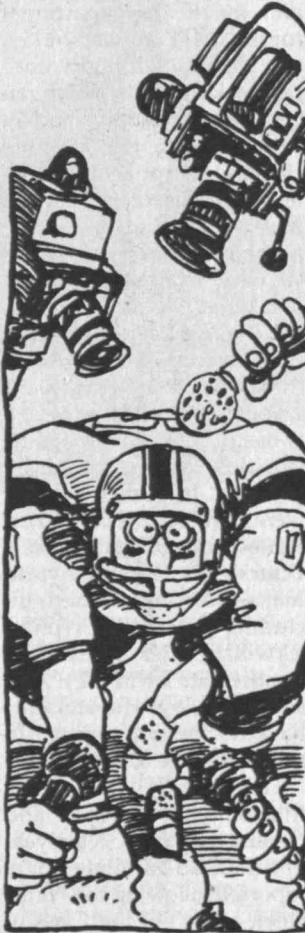
By Friday there was an article on the Associated Press (AP) wire: papers from Alaska to Florida and from Maine to California ran the story, along with a picture of Smith and two of his players at practice. And that evening, Lobel became the first to air a televised report of the story. He used it to end his 6 P.M. sports report and even wove in the "Great Balloon Hack" of the 1982 Harvard-Yale football game—his favorite among stories he's covered.

Saturday was a picture-perfect day for football, and the Beavers played a game that nearly matched the day as they rolled over Stonehill College 29-7. A camera crew and the number-one weekend sportscaster from WNEV-TV, Boston, stayed for the entire game. They sent shots back to CBS in New York, where comedian George Carlin, playing a sportscaster, also contributed to the story. The ABC piece that was shot Friday showed Beaver running back Shane LaHousse, '90, in class leading the MIT cheer. *USA Today—The Television Show* covered the entire game and gave extensive footage to WLVI-TV, their Boston affiliate.

Tim Horgan, a sports writer for the *Boston Herald*, covered the game for the Sunday edition. Michael Blown was on hand, gathering material for an op-ed piece in the *Boston Globe* on how MIT plays college football as it was intended to be played: student-athletes playing for the enjoyment of the game.

As the season progressed, others came to call: Ted Turner's cable superstation, WTBS-TV, did a three and a half minute story; Boston's Channel 5 devoted a segment of its public affairs program to MIT's varsity football; Host Communications, a Louisville, program syndicator, did a story that was sent to radio stations throughout the United States; and team members' hometown newspapers and *Sports Illustrated* also checked in for an update.

President Paul Gray, '54, says that at every gathering at which he speaks people want to talk about MIT football. In





Dean of Engineering Gerald L. Wilson, '61.

a speech before the Faculty Council, Gray held up a copy of the *USA Today* article and said, "Moving to NCAA Division III in football has brought more publicity to the Institute than anything since we had two Nobel Prize winners named in the same week a year ago."

Smith, when asked by a reporter if things had changed with the move to Division III, replied with a smile, "It must have; guys like you keep showing up every week and asking me that question."

"Actually, we thought going to Division III might be somewhat of a story, but since so little is different in our way of preparing and playing, we really didn't expect anything like this."

"It's kind of ironic. We've had football for ten years and very few people cared about us. I feel badly for the players who helped us get to this point and haven't been able to share in the spotlight."

—Roger Crosley □

ROGER CROSLEY is the director of sports information at MIT.

Ten-Year Low for EECS Enrollment

IT appears to have a reprieve from the prospect of a metamorphosis into the Massachusetts Institute of Electrical Engineering and Computer Science.

Four years ago, the number of declared electrical engineering majors continued

to soar, and the faculty and administration gave considerable thought to restricting choice of major in order to bring the numbers under control and maintain balance in engineering.

The record high in 1983 of 380 sophomores choosing to join the EECS department forced MIT to seriously, although unwillingly, consider taking steps which ran counter to its tradition and intent. Instead, the Institute chose to adopt a more cautious gamble of persuasion and patience to see if the numbers would decrease and stabilize without draconian measures.

"Give a hoot, don't compete" became a watchword; there was a campaign to make students aware of the diversity of study and career opportunities throughout the Institute. In particular, they were alerted to the computer-related work going on outside Course VI. Several hybrid majors were established, including Course VIII-A (physics with EE) and Course XVIII (mathematics with EE). And since 1984, transfer students have not been permitted to major in the department.

The statistics now show that students listened and heeded the advice. A ten-year low in EECS enrollment was reported following the "fifth-week count" of the Class of 1992, with 245 sophomores

declaring for EECS. From 1947 to 1976 there had been a steady 200 or so per year, and mid-200s is now considered optimal. □

Four Years Not Enough to Educate an Engineer

Dean of Engineering Gerald L. Wilson, '61, has thrown down the gauntlet to his fellow engineering educators, particularly his colleagues on the MIT faculty. In giving the Robert Bruce Wallace Lecture, sponsored by the Department of Ocean Engineering in October, Wilson focused on two symptoms indicating that all is not well with engineering education in this country:

- First, said Wilson, is the difficulty U.S. manufacturing is having building products that are competitive in the world marketplace.
- And second is the increasingly adversarial relationship between science and technology on the one hand, and society on the other.

While admitting that many factors contribute to this situation, Wilson "a large measure of the responsibility for the lack of American manufacturing competitive-

ness on poor engineering—in the definition, design, production, and delivery of products."

"And if it's true that our engineering is poor," he said, taking the next logical step, "then part of the blame must lie with the way we educate our engineers."

Wilson said that American engineering schools, including MIT, must rethink their "too narrow focus on specific engineering disciplines"—a focus nurtured by faculty whose "intellectual achievements are miles deep but only meters wide." They must develop in their students the motivation and skills required to work in and lead socially responsive, interdisciplinary teams. He said educators must revamp curricula that focus on analysis while short-changing synthesis, and must address the impact on human societies of the products of engineering.

Doing all that without sacrificing any of our commitment to scientific and technological rigor, Wilson said, requires that we "abandon the delusion that we can produce people ready to undertake a professional engineering career in four years." He eschewed a five-year undergraduate degree and instead called for a simultaneous broadening of the undergraduate program and a redesigned graduate curriculum. Together, these restructured degrees could offer both preparation for a professional engineer and a foundation for lifelong learning.

In an interview with Dean Wilson in the February/March issue, *Technology Review* will pursue some of the questions raised by his address. □



ALUM NEWS

Marketing Draws Record Crowd

A program that promoted marketing as "the key to the top and bottom lines" and featured lessons from such experts as Sally Frame Kasaks, Regis McKenna, Thomas J. Perkins, '53, and Jay S. Wurts, '70, drew a record turnout of more than 500 to the annual fall workshop of the MIT Enterprise Forum.

The workshop was held in Cambridge in late October, and offered participants a sampler of some 20 speakers and discussion leaders with years of experience in marketing.

Sally Kasaks, most recently chairwoman of Talbots, Inc., warned her audience that "You can't go forward looking in the rearview mirror. . . . Don't try to educate the customer; let the customer educate the entrepreneur—you."

Jay Wurts, chairman and CEO of Symbolics, Inc., presented a variation on Kasaks's theme: "No one got rich building what customers didn't want." And he went on to caution against investing a lot of money chasing a customer who wants something that can't be built.

Regis McKenna, chairman of a marketing consulting company that bears his name, said he tries to "hang out where things are boiling and bubbling. . . . You need intuition and solid information. If you don't have the touch, all the statistics in the world can't help." McKenna said that what he learned from the

marketing of Intel's first microprocessor gave him the background he needed to make a marketing success of the first Apple computer.

Thomas Perkins' formula for success is quickly stated but not so easy to fulfill: "Establish a proprietary position in an expanding market area, period. We've succeeded ev-

ery time we've followed that formula." He did it with Genentech, Tandem Computer, and LSI Logic. As chairman of three companies traded simultaneously on the New York Stock Exchange, Perkins is unique among U.S. entrepreneurs, and he was the workshop's keynote speaker.

"Market share is *everything*," Perkins said. "It's tough to be number two." If he's in that number-two spot, Perkins' strategy is simple: redefine the market so you have a dominant share.

"Don't confuse great marketing with great products," warned Perkins. "You have to have both." □



One item on the agenda for the Lord Corporation's Third National Symposium on Technology and Society, held at MIT in October, was bestowing Lord Foundation Awards on (from left) science fiction author Isaac Asimov and MIT Professor Jay W. Forrester, S.M. '45. (Shown with Asimov and Forrester is Donald S. Leslie, a member of the Lord Corporation Board of Directors.)

Asimov's award recognized his "development and

promotion of creative techniques in writing and communication that foster . . . understanding of science, technology, literature, the arts, and a diversified spectrum of human activity."

Forrester's award recognized his development of core memory, his contributions to system dynamics, and his applications of the principles of dynamic systems to decision processes in large organizations.

Also honored was Edwin H. Land, a long-time sup-

porter of MIT whose work in synthetic chemistry and optics led to a major industrial enterprise.

The theme of the symposium was "Allowing for the Creative Individual in Corporate and University Cultures," and included addresses by Lester Thurow, dean of the MIT School of Management; Alan Mulally, S.M. '82, general manager of advanced programs at Boeing; and Jordan J. Baruch, '48, of Jordan Baruch Associates.

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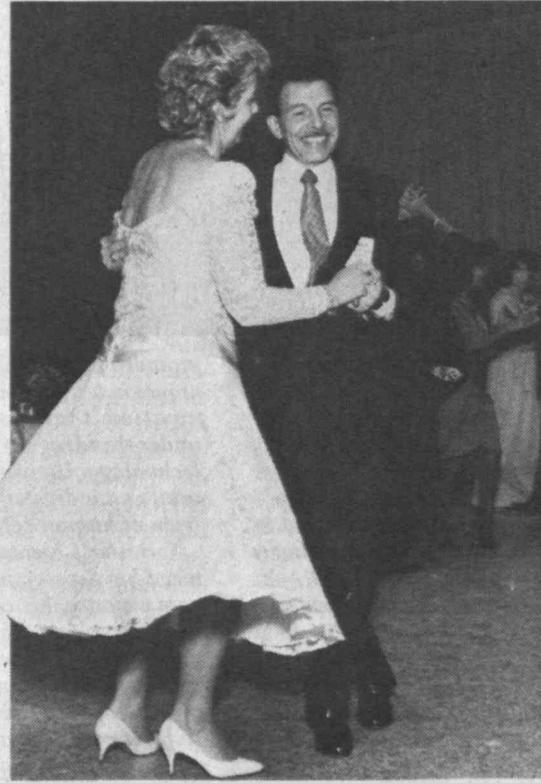
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(Above, left to right) Ken Brock, George Lim, and Norman and Esther Kee. (Right) Members of the Logarhythms singing at the MFA. (Lower right) David Vigoda and Marty Billett. (Below) Mr. and Mrs. Larry Manoni demonstrating all the right moves.



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Everyone Was "In the Mood"

The Class of 1948 converged on the MIT campus over Columbus Day Weekend to celebrate the 40 years that have elapsed since their days at Tech. It was an attractive, lively, and thoughtful group, and their choice of speakers and activities reflected their breadth and depth.

The social highlight of the weekend was a dinner dance in Walker Memorial Hall, rendered almost unrecognizable to its former frequenters by a



(Left) Curtis Green and friends admiring a sculpted ice beaver in Walker Memorial Hall. (Below) Milton Slade. (Center, left to right) William and Elisabeth Maley, Ann and George Macomber, Virginia Clifford, Mrs. Bolan, George Clifford, and Peter Bolan. (Bottom, left to right) George Clifford, Denman McNear, and Sonny Monosson enjoying the Logarhythms' performance.



sparkling disco ball and elegant table settings and cuisine. In tuxedos, suits, and gowns of every description, couples worked off the rich beef chausseur and Bavarian ganache by dancing until midnight. Energy was in abundant supply as they whirled and jitterbugged to swing music provided by the Ralph Stewart Band.

But for sheer elegance, even a glitzed-up Walker could not compete with the buffet served in the medieval Tapestry Room at the Museum of Fine Arts on the previous evening. The Logarhythms provided a postprandial treat

that delighted its audience even while it left them hungering for more. Although the singing group had only worked up a repertoire of a half dozen or so songs, no one would have minded if they'd simply sung them through all over again. It was just the kind of atmosphere that makes one not want to be anywhere else at that moment.

Days were filled with a stimulating array of speakers, from Dean Lester Thurow of the MIT School of Management on "Can America Compete in a World Economy?" to Associate Provost Samuel Jay

Keyser on the sources and psychology of advertising campaigns.

In between, Daedalus Project Manager John Langford, '79, talked about the historic flight; Assistant Professor of Civil Engineering Alex Slocum, '82, spoke on automated precision manufacturing; Professor of Management Edward B. Roberts, '57, discussed technology development; and Professor of Mechanical Engineering Woodie C. Flowers, Ph.D.'73, gave a talk on "Teaching Students That They Are Creative." The final speaker Sunday morning was

Dr. Barrie S. Grieff of the Harvard University Health Service on the transition to retirement. There was indeed a smorgasbord of food for thought, and 40 years had not dulled the appetites of the Class of '48. □





Allan S. Bufford, '59, and Richard Jacobs, '56 (top, left to right), two of the four 1988 recipients of the Bronze Beaver Award.

Kudos and Thanks

October's Corporation Luncheon served also as the venue for honoring the recipients of the Association of Alumni and Alumnae annual awards for outstanding contributions to the Institute.

Bronze Beavers, the highest honor bestowed on individuals by the Association, were awarded to four alumni:

□ **Horatio L. Bond**, '23, for "his years of sustained high-level interest in and concern for MIT and the Association, [serving as] Corporation member class secretary for 23 years, vice-president and president of the Alumnae/i Association, and recently, chairman of the Class of 1923's 65th Reunion gift committee."

□ **Donald J. Atwood, Jr.**, '48, for "invaluable contributions to Association and Institute affairs, filling leadership roles in the Second Century Fund, the Leadership Campaign, the National Business Committee, the Corporation Development Committee, and as an alumni member of the Corporation."

□ **Richard A. Jacobs**, '56, who, "understated in manner, is extraordinarily effective in collaborative efforts—drawing out a wide spectrum of views. As president of the MIT Club of Chicago, member of the Association Board of Directors, and chairman of the Alumni Fund Board, his leadership qualities have made him an outstanding model alumni volunteer."

□ **Allan S. Bufford**, '59, long-time Institute staff member



The first winners of the Kane Award are (center, from left) Robert Johnson, '63, Leon Kaatz, '64, and Harris Weinstein, '56.

(Bottom, from left) Robert Schulte, '71, Donald Moore, '24, and Aaron Kleiner, '69, announced recipients of 1988 Lobdell Awards.

who has also been an "outstanding MIT volunteer since graduation, leader in the Boston Stein Club, solicitor for the Second Century Fund and the Leadership Campaign, member of the Fund Board, and telethon caller without peer."

The 1988 Harold E. Lobdell, '17, Distinguished Service Awards were announced for seven alumnae and alumni:

□ **Yee Wah Chin**, '74, for her "dedicated work for the Educational Council, AMITA, the Alumni Fund, and especially for the New York Center."

□ **Aaron Kleiner**, '69, for his "deep and continuing commitment to the MIT Enterprise Forum."

□ **Donald E. Moore**, '24, for "64 years of quiet strength and leadership of the MIT Class of 1924."

□ **William E. Murray, Jr.**, '67, for "sustained and focused efforts on behalf of the MIT Club of Northern California."

□ **W.M. Kimberly Roddis**, '77, for her "contagious enthusiasm and flawless organization of the immensely successful AMITA scholarship program."

□ **Robert N. Schulte**, '71, for "exceptional service to the MIT Educational Council, the Alumni Fund, the MIT Club of St. Louis, and the Board of Directors of the Alumni Association."

□ **Gwendolyn M. Wise**, '80, for "extended, intensive service in the development and organization of BAMIT and its communication with MIT and the Alumni Association."

Five people received the George B. Morgan Award recognizing sustained excellence in work for the Educational Council: **Marshall E.**



(Above, left to right) Morgan Award recipients James Levitan, '45, Marshall Baker, '48, and John Flynn, '50.

Baker, '48, Wilmington, Del.; Terrence D. Chatwin, '63, Salt Lake City; John R. Flynn, '50, Rochester, N.Y.; James A. Levitan, '45, New York City; and Edward L. Stevens, '48, Kansas City.

The Henry B. Kane Awards, conferred for the first time this year, recognize alumnae/i who have been noteworthy fundraisers. "Chick" Kane, '24, was the first director of the Alumni Fund, serving from 1940 to 1966, secretary of his class, and a nationally known photographer, illustrator, and author of books on wildlife. He suggested and designed the original Bronze Beaver Award. 1988 Kane Award recipients are: L. Robert Johnson, '63; Leon M. Kaatz, '64; and Harris Weinstein, '56.

Presidential Citations, also awarded at the luncheon, will be covered in the February/March issue of *Technology Review*. □

FOR THE RECORD

CONTINUED FROM PAGE MIT 3

simple curve, is an astoundingly complex shape. Although the shape is generated from a formula that determines each point in terms of the previous point, there is no equation analogous to the equation for the ellipse that describes the collection of points overall. The only way we can investigate this system is through point-by-point computer simulation.

In our classes at MIT, we tend to ignore such complexity and concentrate on the simple cases—the ones for which we have formulas. We drill students on how to progress from formula to formula. And in the process, the drive to really understand the world is replaced by a drive to get neatly packaged answers: the *Dragnet* mentality.

It's as if we've been sitting at the side of a swimming pool, making a detailed study of the patterns of light formed on the bottom of the pool by tiny waves on the surface and pretending that we now un-

derstand it all. But then someone dives into the swimming pool and stirs things up, revealing a universe of patterns we never imagined existed.

In the same way, the spread of computer simulation to investigate complex systems makes it increasingly difficult to ignore the universe of phenomena that is beyond the reach of simple formulas. And this in turn will put pressure on the introductory curriculum. We can hope that it will engender both a sense of confusion and of new possibilities. It's precisely this confusion that is the source of my optimism, because it will destroy the agreement about what is "the right material to cover" that so cramps our introductory subjects.

In his October column, Frank Solomon attacked the attitude of a scientific community that considers it worthless to encourage general creativity, in the belief that only the truly self-sufficient geniuses, the

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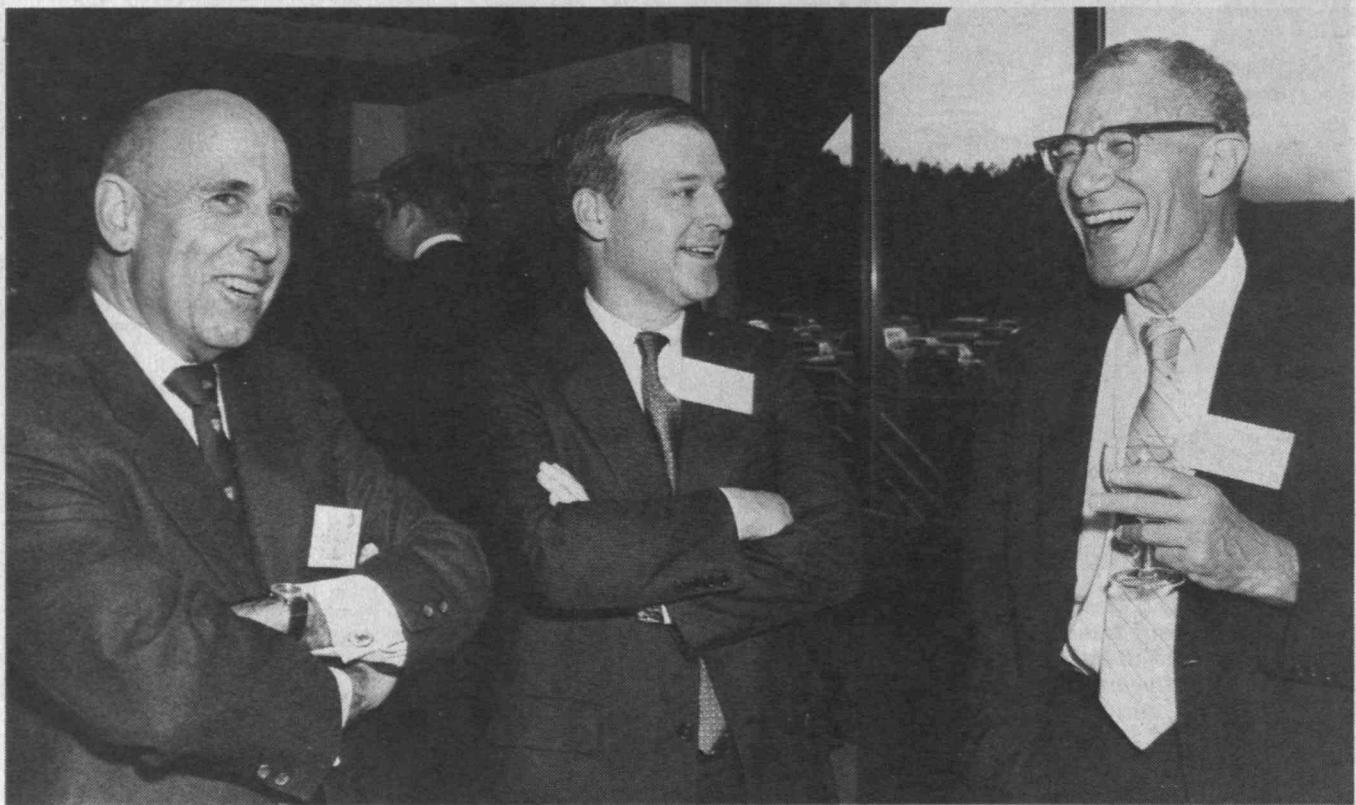
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Mozarts and the Beethovens, will produce valuable work. To build on this image, it's true that Mozart and Beethoven represented rare flowerings of genius. But we should also appreciate that they lived in an exciting period, when new possibilities opened up in music, largely through the invention of the piano. Composers were now able to create keyboard music with dynamic range. Not only Mozart and Beethoven, but others such as Salieri and Clementi, were part of that ferment and produced, if not works of genius, then works at least of charm and nobility.

We should not expect that injecting fresh air into our curriculum by studying complex systems will make much difference to the progress of a young scientific Mozart. But it should generate a climate in which many budding Salieris and Clementis can flourish, and that's not such a bad thing for an educational institution to aim for. □

CEO of Citicorp and Nobel Economist, Head to Head



John Reed, '61, chairman and CEO of Citicorp and holder of bachelor's and master's degrees from MIT, and Robert Solow, the third MIT economist to receive the Nobel Prize in Economics (and one of Reed's professors), shared the podium at the San Francisco launch of the *Campaign for the future* in October.

Before a select group of MIT graduates and friends of the Institute and their spouses and guests at the St. Francis Yacht Club, the pair tackled "The Economic Agenda for the Next Administration." Given the reputed conservatism of the banking and business communities represented by Reed, and the reputed liberalism of academic economists represented by Solow, one might have anticipated some fireworks. But they were on the same wavelength.

The View from Citicorp's Window

There will be intense scrutiny of the people and policies that the new administration puts into place, Reed said, and establishing credibility will be an early priority.

"Having a sense of purpose and display-

ing that sense of purpose is required of U.S. economic performance," Reed said, adding, "You've got to get that fiscal deficit under control."

"We're in a unique period," said Reed. "All of the conventional measures of economic performance are in good shape. That has not been true in the last 20 years." He noted that economic growth is looking good—probably 4 percent real growth this year. Unemployment and inflation are at acceptable levels.

"The dilemma to the new administration is that the traditional tools for managing the economy are wildly out of kilter, maybe even dangerously so," he went on. "You have very high real interest rates . . . a fiscal deficit that is out of whack and quite high compared to our savings rate. . . . We are living in a world in which the only tools for economic management are monetary tools."

Reed said that the new administration will have to correct all that, and he believes that the fiscal imbalance could be corrected in such a way that it "would not be unduly destructive. Indeed, we are at a period of time when some revenue generation probably would not hurt the econo-

my and would give the interest rates permission to relax. . . . Frankly, a dropping of interest rates would have a positive effect on the global as well as domestic situation. . . . [I urge the president to] come up with a program that is balanced between revenue and cutting, which I think is probably do-able, and to get that into his first shot with the Congress."

Clearly, the Europeans, not the Japanese, in Reed's opinion, "are to be the biggest problem for the next administration with regard to [global] economic policy and trade issues, and frankly, with regard to the credibility of our own policies."

Reed recognizes that we have a set of issues with the Japanese. "But I do believe that if you look at the record, when push comes to shove, Japan and the United States in fact find ways of accommodating. . . . The Japanese are very firmly linked into the same view of the global economy that we have; they are linked into the same view of the necessity for productivity

for investment.

"The Europeans, on the other hand, are fundamentally not willing to try to be truly competitive with people who are willing to work six days a week, eight hours a day. They are more inclined to close their economies and to maintain cartel-like structures," he said, and they are hanging on to their subsidies on agricultural products.

Reed said that he wouldn't worry about the dollar. "It will drop and take care of itself," he said, adding that he "would avoid like the plague the protectionist tendencies that do exist and could be implemented by the Congress."

In Saving, We're Behind Portugal

Bob Solow agreed with John Reed that we are in some respects in good shape now. "We have had a very good 1980s in the United States. We have had a prospering economy, did much better than competing economies in Europe in many ways. . . . But we engineered a consumption boom that was financed by borrowing from foreigners.

"The particular thing that I would like to ask the next president to accomplish is to convert the United States from a high consumption economy to a high investment economy." He said he not only referred to investment in industrial plants and equipment, but also to investment in human capital—in education and training of our population, in technology and science. And we should be financing that out of our own savings, he emphasized.

Historically, Solow said, private saving in the United States has been low. Many other countries save and invest a much larger fraction of their GNP than we do—poorer countries like Portugal as well as rich countries like Germany and Japan.

"It seems to me very unlikely that anything the next president could do could make a drastic change in the private savings habits of the American economy," he continued. "But we do have in the United States a made-to-order way of increasing our national savings rate, and that's by reducing the federal budget deficit."

"It may be that we should . . . aim our fiscal policy at having a surplus in the federal budget while the economy is prospering, [thereby] reducing the public debt and diverting that part of our private wealth to the formation of industrial capital rather than the financing of public debt.

"That's the easy part of what I have to



The glittering assembly included (top) Betty and Stephen D. Bechtel, Jr., and (bottom, left to right) Maryla and Peter Wallace, '55, and Doris Bossen.

tell the next president," Solow said. "The next part is not so inspirational. The only way we have to make a substantial reduction in the federal budget deficit is through tax increases."

Solow was asked why he is so confident that most of what we have to do about the deficit has to come from the revenue side. How about budget cuts?

"We have in fact done a lot of budget cutting in the last eight years," Solow said. "In 1979 or 1980 that part of the federal budget that was not interest payments on already existing debt, not defense, not Social Security or Medicaid was something like 5 or 6 percent of GNP. It's been cut by a whole 2 percent. What's left of the budget is those three other items."

"Are we going to cut a lot from the defense budget? I leave that up to you," Solow told his San Francisco audience. "You probably know more about it than I do." But he sees little reason to expect significant cuts in defense.

With regard to interest: "The interest bill

for the federal government is going to go up, not down, for the simple reason that we are still running a deficit of \$150 billion per year. . . . In the next few years, there may be short-run reductions in interest rates, but until we do something drastic to the budget, we're not going to see vast reductions in nominal interest rates.

"That leaves social security. . . . You could bring in a few billion dollars by taxing social security benefits." But again, Solow said that the savings would pale beside a deficit running at 3-1/2 percent of GNP in a very good year.

And the fourth item is just too small to offer help with the deficit. That left Solow where he started: taxes.

Taxes by Any Other Name . . .

Solow disagrees with Reed about the potential impact of a tax increase (what Reed referred to as "revenue generation"): "A tax increase, or anything that we do toward reducing the federal budget deficit, will have a contractionary effect on our economy as a whole," Solow said.

"I try to explain to my students that the bad thing about economics is not just that everything depends on everything else; [it's] that everything depends on everything else in two ways!"

"The problem about our fiscal policy in this country is that the budget deficit, while it is a drain on our national savings and therefore a drain on our future productivity and our future standard of living in the long run, is a support to our economy in the short run. Just as the deficits of the past six years have kept the economy moving upward, we run a terrible danger that reducing or eliminating those deficits will generate a recession."

He said that the new president should try to cushion the contractionary effect of a more austere fiscal policy by the expansionary effect of an easier monetary policy.

"For a very long time, Paul Volcker would appear before the Congress four times each year and offer them a deal (to the extent that the chairman of the Federal Reserve Board can offer a deal to the Congress): 'If you will tighten fiscal policy, I will ease monetary policy.' And 24 times, there were no takers for that deal.

"I have some hope that come next January or February, the president would be willing to accept that offer, which I feel quite certain Alan Greenspan would be prepared to renew." □



COURSE NEWS

I CIVIL ENGINEERING

On the 20th anniversary of Project Software and Development, Inc., an accolade to the company founded and still headed by **Robert L. Daniels**, S.M.'66; *Mass High Tech* writes that the company "has helped define this often-confusing market, where educating the buyer is the hardest part of making a sale." The occasion was PSDI's introduction last fall at DECworld in Cannes, France, of a new version of its project management software, Qwiknet Professional, that runs on DEC VAX computers. Earlier in the year PSDI made news by donating some \$1-million-worth of its software to help manage the Calgary Winter Olympic Games.

Questionnaires for the new *Alumni Register* have brought reports from five alumni. **K. Peter Devenis**, C.E.'56, is senior vice-president and director of the Environmental Division at CE Maguire, Inc., Waltham, a job that apparently gives him time for the two hobbies he listed—golf and travel. . . . From Alexandria, Va., **Joseph A. Jansen**, S.M.'52, reports his retirement from the Federal National Mortgage Association. Jansen studied Chinese for military service in the Hong Kong consulate, Korea and Vietnam; then, "as sometimes happens in the military, my career became heavily personnel-oriented." So following military retirement he went into the personnel field, writes Jansen, in which he still occasionally consults. . . . **William C. Stoekey**, S.M.'51, is chairman of the board of Wilddan Associates, Anaheim, Calif.; he lives in nearby Fullerton, enjoying his two hobbies of aquaculture and Soviet travel. . . . **Harry N. Wallin**, S.M.'37, retired from the Bechtel Group, Inc. and living in San Mateo, Calif., writes, "I have been active in fundraising for the Society of American Military Engineers Scholarship Fund—mainly through our annual golf tournament." . . . Wallin's classmate, **Thomas W. Anderson**, S.M.'37, is chairman of the Concrete Technology Corp., Tacoma, Wash., and mentions important civic and professional achievements: listed in three editions of *Who's Who*, a trustee (for 22 years) of St. Joseph's Hospital, Tacoma; president (1967) of the Tacoma Rotary Club, and a member of the Board (1967-83) of the first Interstate Bank of Washington.

Daniel Brand, S.M.'61, who manages the transportation program at Charles River Associates, Inc., Boston and Washington, is now chairman of the Transportation Research Board's Task Force on Advanced Vehicle and Highway Technologies. It's important work, says Brand: "Through the efforts of this task force . . . we may see a revolution in the way urban traffic congestion is handled over the next five to 15 years."

From Andover, Mass., **Warren H. Oldaker**, S.M.'53, writes that he has retired as chief of quality assurance for Region I of the EPA in Lexington, Mass., after a career that is documented in his 30 professional papers and his three years' service as a technical professional witness on environmental cases before the U.S. Supreme Court. His retirement interests include calligraphy, woodworking and construction, photography, classical music, bird watching, and military activi-

ties—the latter reflecting the fact that he is a retired army officer.

The Alumni Association has been informed of the death in April 1987 of Colonel **Vincent C. Frisby**, S.M.'40, in Boise, Idaho; details are not available.

II MECHANICAL ENGINEERING

Harmon L. Liebman, S.M.'54, has retired—but you'd hardly know it. He's now president of HiQ Services, Inc., Holtwood, Pa., consulting to the food and chemical industries on product/process development and quality assurance. Liebman came to Lancaster, Pa., in 1965 to start Eastern Freeze-Dry Corp., developing freeze-dry processes for the food and polychemical materials industries and the military, and a line of freeze-dried foods for backpackers and campers. In 1980 Hanover Brands bought the Lancaster facilities, and Liebman became technical director of the consolidated companies; they were renamed Dehydro Fresh in 1980. Before 1965 Liebman had been associated with General Foods' Birds-Eye Division, O'Donnell-Usen Co., Foxboro Co., and Stokes Division of Pennwalt.

Jack B. Chaddock, Sc.D.'55, is associate dean for research in Duke University's School of Engineering; he was chairman of mechanical engineering and materials science at Duke for 20 years beginning in 1968, and in between those two assignments he had a sabbatical year at the University of California at Berkeley. Chaddock maintains an active role in the American Society of Heating, Refrigerating and Air Conditioning Engineers, of which he was president in 1981-82, and he will be chairman of an international symposium on heat and mass transfer in building materials and structures in Dubrovnik, Yugoslavia, next September.

News from MIT: Two associate professors in the department, **Ahmed F. Ghoniem** and **Anthony T. Patera**, Ph.D.'82, have been granted tenure. Ghoniem came to the U.S. from Egypt for graduate study at the University of California at Berkeley (Ph.D.'80), arriving at MIT in 1983; his field is computational fluid dynamics and turbulent flow. Patera has been at MIT since entering with the class of 1978, and he, too, is a specialist in fluid dynamics; his work in flow stability, widely known, has led to new methods for heat transfer augmentation. . . . Assistant Professor **Emanuel M. Sachs**, Ph.D.'83, now holds MIT's Rockwell International Career Development Professorship. Sachs teaches undergraduate and graduate courses in manufacturing and its integration with design; his research is in design for manufacture and modeling manufacturing processes. . . . Professor **John B. Heywood**, who directs the Energy Laboratory's program on transportation propulsion, is the author of *Internal Combustion Engine Fundamentals* (McGraw-Hill, 1988); it's described as "a major professional reference and text [that] . . . provides a simplifying and integrating framework for understanding the complex mass of technical material on spark-ignition and diesel engines."

To **Kyriakos Komvopoulos**, Ph.D.'86, assistant

professor of mechanical and industrial engineering at the University of Illinois, Urbana-Champaign, ASME's Burt L. Newkirk Award. It recognizes contributions to tribology through R&D by an individual under age 35, as shown by papers published in ASME's *Journal of Tribology*.

. . . **J. P. Barger**, M.E.'56, cofounder, president, and CEO of Dynatech Corp., Burlington, Mass., has been elected a director of Cambridge Medical Technology Corp., Billerica, Mass.

Michael L. Gallagher, S.M.'82, is finishing an M.B.A. at Harvard Business School and has joined Hewlett-Packard in Waltham, Mass.; his son Daniel is now one and a half. . . . **Charles J. Szollosy**, S.M.'85, will soon retire from the U.S. Army; meantime, as a first lieutenant he is a project coordinator at the U.S. Army Tank Automotive Command. . . . It's obvious why **Sidney A. Whitt**, S.M.'37, retired to Bozeman, Mont., when he left the faculty at SUNY in 1979: his hobbies are hiking, hunting, cross-country skiing, and "keeping our 'historic house' in shape." In addition, Whitt, who celebrated his 80th birthday last March, is a member of the Scholarship Committee for the College of Engineering, Montana State University, and wrote a report—apparently unique—on a stress analysis of the crucial solid booster rocket joint that failed in the Challenger space shuttle in 1986.

On questionnaires for the new *Alumni Register*, alumni report: **John O. Outwater**, Sc.D.'50, professor emeritus at the University of Vermont, has two hobbies: machine building and chess, in which he has twice been the state champion. His publications have been in a wide variety of fields: tree mechanics, archaeology, composite materials, glass, and ski safety. . . . **John W. Hansborough**, S.M.'35, retired from the U.S. Army, is living in Austin, Tex. Hansborough's military career included service in the Philippines from 1939 to 1941 and staff assignments with Generals Patton, Clark, and Patch; his final assignment was command of the 34th Field Artillery Brigade, Fort Sill, Okla. Present hobbies: travel, archaeology, and genealogy. . . . In 45 years of teaching agricultural engineering at the University of Wisconsin, **Hjalmar D. Brunn**, S.M.'37, was the author of 150 scientific papers, participated in some 20 conferences worldwide, and, with his graduate students, developed and improved many innovative machines for harvesting and processing farm products. His present activity is "developing and building village-sized equipment for the production of alfalfa juice protein for several hundred undernourished children in the alfalfa-producing area of Mexico south of California and Texas."

. . . **Leonard Kraner**, S.M.'54, is president of Miller Dial Corp., El Monte, Calif., and a part-time teacher of small business management at California State University, Los Angeles. . . . **Theodore W. Tucker**, '55, is the owner and proprietor of The Forgery, Lincoln, Mass. In his words, it's "a small company to supply authentic wrought iron hardware and articles for museum and private restorations. While welded and painted scrap iron is common," writes Tucker, "the number of artisans capable of highly skilled workmanship is decreasing. Uncovering the original techniques and the style of the smiths in each

locale (while at the same time contacting customers) is a full-time job."

After nearly 35 years at Rockwell International, where he is now project engineer in the Rocketdyne Division, **Charles L. Faulders**, Sc.D.'54, writes that "with a doctoral degree from MIT in mechanical engineering you're ready for anything." That's been his experience: "I've had the good fortune to see firsthand, and participate in, projects as varied as the Apollo program, the start of the space shuttle program, synthetic fuel projects using coal and oil shale, and now a geothermal power plant we monitor for the U.S. Department of Energy." But now, writes Faulders, he's thinking about retirement. And he finds that "things are coming full circle. The other day, a young engineer to whom I introduced myself said he'd seen my name in a textbook on steam turbines he'd been using a short time earlier. Yes, I said, that was some research I did at MIT. We figured out that I had published the paper about six years before he was born."

III MATERIALS SCIENCE AND ENGINEERING

Four alumni were honored at the World Materials Congress of ASM International in Chicago last fall: **Richard K. Pitler**, '49, was installed as president of ASM International for 1988-89; **Klaus M. Zwilsky**, Sc.D.'59, became vice-president and will be president in 1989-90; **Robert W. Balluffi**, Sc.D.'50, received the Acta Metallurgica Gold Medal for 1987, and **Steven S. Hansen**, Sc.D.'78, shared the Marcus A. Grossman Young Author Award. Pitler is retired senior vice-president/technical director of Allegheny Ludlum Corp., a company he joined in 1950; at the time of his retirement he was also general manager of Allegheny Ludlum's Special Materials Division. Zwilsky is executive director of the National Materials Advisory Board of the National Research Council. Balluffi's award is considered a major international prize; it recognizes "outstanding ability and leadership in materials research." The recipient, a specialist in structural imperfections in crystalline metals, has been professor of materials science at MIT since 1978. Hansen is supervisor of the Steel Products Development Group at Homer Research Laboratories, Bethlehem Steel Corp.

A new technology for producing spin-coated thin films of bismuth-containing superconducting oxides conceived by **Yet-Ming Chiang**, Sc.D.'85, Mitsui Career Development Associate Professor of Contemporary Technology at MIT, has been licensed to American Superconductor Corp., Cambridge, of which Chiang is cofounder. The films can carry currents in excess of 500,000 amperes per square centimeter at 4.2 degrees K, according to a recent report by Chiang to the American Ceramics Society. **Gregory J. Yurek**, MIT professor of metallurgy and chief technical officer at American Superconductor, told *Mass High Tech* that the new technology will make possible "substantial" increases in the speeds of many microwave devices.

Carl V. Thompson, '76, associate professor of electronic materials at MIT, has received tenure on the MIT faculty; at the Institute since 1982, Thompson is a specialist in the microstructure of thin films for electronic applications. . . . **Linn W. Hobbs**, professor of ceramics at MIT, was among judges of Polaroid's 1988 International Instant Photomicrography Competition. . . . **H. Kent Bowen**, Ph.D.'71, Ford Professor of Engineering at MIT, has resigned as chairman of Ceramics Process Systems Corp., Cambridge, of which he was a founder; he remains as a director of the firm.

Douglas W. Fuerstenau, Sc.D.'53, is completing his first year as Malozemoff Professor of Mineral Engineering at the University of California, Berkeley; he has been a member of the Department of Materials Science and Mineral Engineering there since 1959. Two recent periods at the Technical University of Clausthal, Germany, have resulted

from Fuerstenau's receiving a Senior American Scientist Award from the Alexander von Humboldt Stiftung of West Germany. . . . **George Freedman**, '43, formerly director of Raytheon Manufacturing Co.'s New Products Center and now an independent consultant, is the author of *The Pursuit of Innovation: Managing the People and Processes that Turn New Ideas into Profits* (American Management Association, 1988). In its promotion, AMA says "This broad-ranging, fascinating book describes real-world, tested ways to manage innovation for business growth."

Though he's still chairman of the board at Smith Yuill and Co., Inc., Pittsburgh, **Phillip H. Smith**, '52, is looking west—to the Pacific Rim. He's been presenting management development programs for senior executives in China since 1983—a series sponsored by the Department of Commerce and the Chinese State Council; the programs, mostly in long-range planning and finance, are given at the Dalian University of Technology. Smith has also been working to promote technology transfer between the U.S. and Australia, New Zealand, and other South Pacific nations. And as chairman of Inroads, Inc., Pittsburgh, for the past 7 years, he's been helping to bring underprivileged minorities into local business and industry. . . . **James L. Wyatt**, Sc.D.'53, writes that he expects to retire to Boca Raton, Fla., from his job as president of Ambassador Industries, Inc., Los Angeles—no date given. Wyatt has published more than 25 papers in non-ferrous metallurgy and management and has more than 20 patents issued or pending. He's an active boater, a member of the California Yacht Club, and a commercial pilot—a product of his continuing activity in the Air Force, from which he recently retired with the rank of lieutenant colonel.

Roger G. Mora, S.M.'58, of Clermont-Ferrand, France, died on August 13, 1987; details are not available.

IV ARCHITECTURE

William L. Porter, Ph.D.'69, who was dean of the MIT School of Architecture and Planning from 1971 to 1981, is in the administration again, this time as head of the Department of Architecture. Porter was interim head of the department last year, and John de Monchaux, present dean, said that he "displayed great clarity and energy in his leadership of the department [while] at the same time [confronting] in a creative way some of the important issues facing the department today." Porter has been a member of the faculty since 1967, two years before he finished his graduate work in urban studies and planning; he has taught design in both architecture and urban studies curricula, and in 1979 he was the first director of the Aga Khan Program for Islamic Architecture at Harvard and MIT.

A compact disc recording of *Valis*, an opera by **Tod Machover**, assistant professor of music and media in the Media Arts and Sciences Section at MIT, is now available from Bridge Records. The work combines voices, musicians, and an array of electronic music technologies; it's based on the science fiction novel of the same name by the late Philip K. Dick. . . . **Diane T. Georgopoulos**, M.Arch.'82, has been elected president of the Women's City Club of Boston; she practices in Boston as an architect with the Massachusetts Housing Finance Agency. . . . **Harold Horowitz**, M.Arch.'51, retired last fall as director of research at the National Endowment for the Arts after 26 years of government service. He's now "developing a new career and lifestyle in the private world—too soon for details," he writes. . . . **Edward McC. Hicks**, S.M.'35, has already made the break: he's retired in Carmel, Calif., where he is planning commissioner.

From *Alumni Register* questionnaires: **Robert H. Fowble**, M.Arch.'52, heads his own firm in San Diego, but how does he have time to practice ar-

chitecture? He's a member of the San Diego, California, and U.S. Chambers of Commerce (former chairman of the San Diego Chamber's Metropolitan Planning Committee); a 12-year member of the Linda Vista Citizens Planning Board; a 9-year member of the San Diego Joint Advisory Board on Open Space; education chairman for the San Diego Chapter, AIA; charter member of the San Diego Chapter, American Society for Metals; former member of the Council of Educational Facility Planners; and a leader of the M.I.T. Club of San Diego (two terms as president, two as treasurer, and continuing service on its board of directors); and former teacher of extension courses in "Law for Contractors and Journeymen" at San Diego City College and "Electrical and Mechanical Equipment for Buildings" at the University of California, San Diego. . . . In Cincinnati, **Walter F. Shebley**, M.Arch.'33, sounds almost as busy: he still maintains his own firm; for 20 years taught mechanical and free-hand drawing at the St. Rita School for the Deaf; for 20 years sold playing cards of his own design for "low vision" players—a patent that was eventually sold to the U.S. Playing Card Co.; flew his own plane for 15 years; designed and built his own home and two sailboats of 18 and 12 feet; and maintains stamp, coin, and postcard collections.

David McCandless, M.Arch.'51, is a senior associate at the Joiner-Rose Group, Inc., Dallas, and a frequent lecturer and writer on architectural acoustics; his hobbies are jewelry-making and watercolor painting (he's a signature member of the Southwestern Watercolor Society). . . . From his home in Boston, **Safadin Niazmand**, S.M.'83, writes that he is project manager for Lea Management, Hopkinton, Mass., and in his spare time enjoys wind surfing and chess. . . . Another hobby report from **Robert W. Vahlberg**, M.Arch.'37, who practices in Oklahoma City: he sails, flies (3300 hours as a private pilot), and drives in sports car rallies.

V CHEMISTRY

The nation's highest scientific honor came to **Elias J. Corey**, Ph.D.'51, professor of chemistry at Harvard, when he was awarded the National Medal of Science last summer at a White House ceremony. Corey was cited for his successful syntheses of many chemicals occurring naturally in plants and animals—a total of more than 80 complex molecules—leading to "many new medical treatments for illnesses ranging from asthma to ulcers."

Elwood P. Blanchard, Jr., Ph.D.'59, executive vice-president of the Du Pont Co., has been elected vice-chairman of the company's Board of Directors. Blanchard joined Du Pont's research staff upon graduating from MIT, holding assignments in the Film Department before becoming head of the Dyes and Chemicals Division, then general manager of chemicals and pigments. . . . **James D. Burrington**, Ph.D.'77, is the new chairman of the Division of Petroleum Chemistry, American Chemical Society; he is manager of biotechnology research for BP America, Cleveland. . . . Five members of the MIT chemistry community will receive national awards from the American Chemical Society in 1989: **David Chandler**, '66, of the University of California, Berkeley: the Hildebrand Award in the Theoretical and Experimental Chemistry of Liquids; **Scott E. Denmark**, '75, of the University of Illinois, and **Barry M. Trost**, Ph.D.'65, of Stanford University: Arthur C. Cope Scholar Awards; **Tobin J. Marks**, Ph.D.'71, of Northwestern University: the Award in Organometallic Chemistry; and **Henry Rapoport**, Ph.D.'43, of the University of California, Berkeley: the Guenther Award in the Chemistry of Essential Oils and Related Products.

Two members of the department have received tenure on the MIT faculty: **Sylvia T. Ceyer**, Class of 1943 Career Development Associate Professor,

and **Keith A. Nelson**, associate professor. Ceyer has been frequently honored for her teaching since coming to MIT in 1981 from the University of California, Berkeley; she is well known for research on surface chemistry. A specialist in chemical dynamics, Nelson came to MIT in 1982 after completing academic work at Stanford; he received the 1988 Coblenz Award of the Coblenz Society for "outstanding work in spectroscopy by a scientist under the age of 36" and in 1985 was chosen a National Science Foundation Presidential Young Investigator for a five-year term. . . . **Gregory Petsko**, MIT professor of chemistry, chaired the session on "Applications of Computer Modeling" at the New England Biotechnology Association's Worcester Colloquium V last October, giving a keynote paper on "The Scope and Limitations of Modeling in Biotechnology." A paper on "The Design of Protease Inhibitors" was presented by **Dagmar Ringe**, lecturer in the department at MIT.

From **Mark A. K. Patterson**, Ph.D.'82: "I am completing my third year at Albany Medical College, Albany, N.Y., and I hope to do residency training in the field of pediatric neurology with the eventual goal of entering academic medicine. Medical school has a way of crimping one's personal time, but I've tried to keep up with two favorite hobbies, flying and woodworking. I currently have my private pilot's license and hope one day to incorporate flying into my medical practice. I've enjoyed a variety of activities with the local alumni club and through them meeting other alumni." . . . From Kennett Square, Pa., **Robert Goddu**, Ph.D.'51: "Since retirement from Hercules, Inc. in 1984 my principal activities have been travel with my wife (especially enjoyed an air safari to Kenya with the MIT Quarter Century Club), work around my old house and grounds, woodworking, and—perhaps most important—being mayor of the Borough of Kennett Square. My term runs until 1990; then? Have also been involved with the United Way and play tennis two or three times a week. No regrets on retirement, but haven't pursued chemistry further."

Gleanings from questionnaires for the new *Alumni Register*: **Harry W. Linde**, Ph.D.'53, is associate dean and professor of anesthesia at Northwestern University Medical School, Chicago; lives in Evanston; teaches advanced cardiac life support and cardiopulmonary resuscitation; and for relaxation enjoys sailing, boardsailing, and scuba. . . . **Howard H. Rogers**, Ph.D.'53, is a senior scientist at Hughes Aircraft Co., Los Angeles, where his major interest is computer science. . . . Classmate **Roscoe A. Pike**, Ph.D.'53, is manager of polymer science at the United Technologies Research Center, East Hartford, Conn., with 30 publications and 50 patents in polymer and adhesive science to his credit; at home in Granby, Conn., Pike is a trustee, elder, and Sunday school teacher at his church and enjoys stamp collecting and chair caning; and at his Cape Cod summer home he turns to swimming and golf. . . . From San Jose, Calif., traveler **Raymond C. Sangster**, Ph.D.'51, reports he is "between jobs at the moment," having spent 1986-87 in Taiwan helping establish a new National Measurement Laboratory. Earlier he was in Frankfort-am-Main for five years as writer, translator, and English language editor of a German handbook of inorganic chemistry. . . . **Barbara Frances Enagonio**, Ph.D.'50, professor of chemistry at Montgomery Community College, Rockville, Md., is co-author of an organic chemistry laboratory manual published last year by Macmillan. She has three daughters: one a postdoc at Fermilab in physics, one a member of the Navy band in Washington, D.C., and one an airman at Miramar (Calif.) Naval Air Station. . . . From Damariscotta, Me., **William S. Emerson**, Ph.D.'37, recalls that he has written one book (*Guide to the Chemical Industry*, John Wiley, 1983) and more than 50 journal articles, holds 76 U.S. patents, appears in two regional editions of *Who's Who*, and is a member of Delta Kappa Epsilon and Alpha Chi Sigma. . . . **William F. Lewis**, '36, moved to Oceanside, Calif., a

decade ago, where he says "my yard and house work keep me busy." He enjoys the West Coast ("sailing quite different from the Charles River") but despite the good weather his golf is "only fair." Three operations in the last four months left him 40 pounds lighter, but he's on the mend, says Lewis. . . . **Lionel S. Galstaun**, Ph.D.'36, works as a consultant out of his Danbury, Conn., home, specializing in the gasification of fossil fuels, gas purification, and the synthesis of chemicals and liquid fuels. Avocations: woodworking, gardening, and music. Galstaun's late wife was a well-known concert pianist, and he is proud to have established a scholarship in her name at Juilliard, her alma mater.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

For its annual briefing session for the media on new electrical engineering/computer science developments, IEEE called on three members of the MIT community last fall: **Michael Adler**, Ph.D.'71, of General Electric on the emerging technology of "smart power"; **Stewart Personick**, Sc.D.'70, of Bell Communications Research on the role of fiber optics in telecommunications; and **Jay K. Lucker**, director of the MIT Libraries, on new electronics technology for libraries and its implications.

Terry Winograd, Ph.D.'70, associate professor of computer science at Stanford, is president of Computer Professionals for Social Responsibility, and his duties at CPSR's annual meeting last fall in Palo Alto included giving the 1988 Norbert Wiener Award for Professional and Social Responsibility to **Joseph Weizenbaum**, professor emeritus of electrical engineering and computer science at MIT. The award recognizes "extraordinary and exemplary practice of the highest standards of social responsibility in the computing field." (Robert Howard, senior editor of *Technology Review*, spoke at the conference on the role of computer designers in creating socially responsible products.)

To Professor **Jonathan Allen**, Ph.D.'68, director of the MIT Research Laboratory of Electronics, the 1987 Technical Achievement Award of the IEEE Acoustic, Speech, and Signal Processing Society. . . . **Robert G. Gallager**, Sc.D.'60, is the first Fujitsu Professor of Electrical Engineering and Computer Science at MIT; the chair results from a \$1.5 million grant from Fujitsu Ltd., the largest Japanese computer-maker. Gallager's early work was in the field of information theory; more recently his research has centered on computer networks—random access communications, routing, flow control, and distributed algorithms.

Five members of the department at MIT have been given tenure on the faculty:

□ Associate Professor **Robert C. Berwick**, Ph.D.'82, a specialist in computer programs for analyzing natural language who directs the Artificial Intelligence Laboratory's Natural Language Processing Group.

□ Associate Professor **Charles E. Leiserson**, whose field is the theory of computer machinery, combining computer architecture and mathematical problem-solving.

□ Associate Professor **Silvio Micali**, a world leader in cryptography. A native of Italy, Micali studied at the Universities of Rome and California (Berkeley) and taught at the University of Toronto before coming to MIT in 1983.

□ Associate Professor **Charles G. Sodini**, a specialist in the area of technology-intensive integrated circuit design integrating fabrication technology, device physics, circuit design, and system design.

□ Associate Professor **George C. Verghese**, whose field is the application of dynamics to power electronics and electrical machines; he is the Carl Richard Soderberg Associate Professor in Power Engineering.

Three members of the MIT community were prominent at the annual meeting of the National

Academy of Engineering in Washington early last fall. As president of the academy, **Robert M. White**, Sc.D.'50, chose for his annual address "The Emerging Technology Policy Consensus"; he was followed by MIT President **Paul E. Gray**, '54, with a public address on "Engineering as Servant, Not Master." Professor **Thomas H. Lee** of MIT contributed a paper on fossil fuel use to a later session on the role of technology in environmental protection. . . . The 1988 Hammer Forum, a production of **Michael Hammer**, Ph.D.'73, of Hammer and Co., Cambridge, provided a platform for three MIT speakers: Mitchell Kapur, '81, founder of ON Technology, Inc., on "From Productivity to Creativity: A New Role for Computing"; **John W. Poduska**, Sc.D.'62, chairman of Stellar Computer, Inc., on "High-Performance Computing for High-Performance People"; and **Thomas W. Malone**, professor of information systems in the MIT School of Management, on "Reshaping Groups and Group Work."

Robert L. Baber, S.M.'59, is the author of *The Spine of Software: Designing Provably Correct Software—Theory and Practice* (Wiley, 1988). The author's goal, says the publisher, is to bring to software engineers the results in practical terms of recent research in the theory of proving programs correct. Baber, who specializes in seminars in this subject, is a resident of Germany. . . . Associate Professor **Peter Szolovits** of MIT was the instructor for a four-hour tutorial on "Artificial Intelligence in Medicine" at the 12th annual Symposium on Computer Applications in Medical Care in Washington last November. Szolovits directs the Clinical Decision-Making Group in the MIT Laboratory for Computer Science.

Richard M. (Mike) Harris, S.M.'65, is now chief engineer of the C3I Division of Mitre Corp., Washington, D.C.; he continues temporarily as acting director of Mitre's Navy and Information Systems Division, his previous assignment. Meanwhile, **Charles A. Zraket**, S.M.'53, Mitre's president and CEO, was chosen for a new Advisory Council to the Carnegie Commission on Science, Technology, and Government; the commission will study the interface between science/technology and government policy and decision-making. . . . **John C. Wissmiller**, E.E.'65, works in Illinois operations of GTE North, Inc., Bloomington, Ill., applying fiber optics to transmissions between telephone offices. He's finding relaxation, he writes, in learning sign language for the deaf and speech-impaired.

From Livingston, N.J., **Gerald Rabow**, S.M.'52, writes that his principal interest is the application of systems engineering to societal problems with the ultimate goal of peace. That this leads in many directions is evident from Rabow's list of recent publications: "Arbitration as a Means for Solving Major International Disputes" and "The Social Implications of Non-Zero-Sum Games" (*IEEE Technology and Society*), and "New Versions of Scrabble, Bridge, and Basketball to Teach the Advantages of Cooperation" (*Psychology Today*). . . . Classmate **Garwood M. Rodgers**, S.M.'52, has taken a different route in the search for peace; from Duncanville, Tex., he writes, "One of the great things that happened to me since being at MIT was God's leading me to go to seminary. . . . A new and glorious dimension was added to my life." . . . **Roy G. Saltman**, S.M.'55, writes from the National Bureau of Standards that he has a three-year grant from the John and Mary R. Markle Foundation to study the use of computers in vote-counting with emphasis on accuracy, integrity, and security; as a result of earlier work, Saltman had written what is considered the authoritative work in the field: *Effective Use of Computing Technology in Vote-Tallying*. . . . In his career in electrical engineering and computer science at the University of California, Berkeley, **Charles A. Desoer**, Sc.D.'53, has been the author or coauthor of more than 100 papers and 5 books, with two more books now in production. . . .

Emanuel Schnall, S.M.'55, commutes from his home in Encinitas to his job as principal engineer for Honeywell Advanced Marine Systems, San

Diego; his hobbies are folk dancing and sailing. . . . After 19 years' experience in the field, **Sidney F. Quint**, S.M.'50, started his consulting business in his home in Milton, Mass., on computer and communications systems for the airline and travel industry. . . . **Sol P. Kurtzman**, S.M.'53, reports that he is completing 35 years' service in engineering and administration for the U.S. government (unfortunately, the agency isn't indicated). "My wife and I are looking forward to retirement," he writes, "to enjoy our hobbies of golf, gardening, square dancing, traveling, and learning. My particular interests these days are history and human growth and potential."

Meanwhile, two alumni already retired report in for the new *Alumni Register*: **George B. Hoadley**, Sc.D.'37, writes from Raleigh, N.C., that he and his wife had enjoyed travel until Mrs. Hoadley's hip was broken on their last trip. "So now we shall stay at home," writes Hoadley. "Anyhow, travel looks less pleasurable than it was; the world has become so quarrelsome." . . . **James J. Hitt**, S.M.'52, retired from Leeds and Northrup Co., writes from Broad Axe, Pa., that he is looking for one or more graduate students to work with him on "an advanced automated highway-car system."

Bernard J. Regenauer, S.M.'56, died suddenly on August 27, 1988, at his home in Sudbury, Mass. He was 61, a senior staff member at Dynamics Research Corp., Wilmington, Mass., where he had worked since 1977; earlier he had been associated with Mitre Corp. and Raytheon Co. Regenauer attended the U.S. Naval Academy, Annapolis, and had served in the Navy during the Korean War before entering MIT. . . . The deaths of **Joseph K. Dillard, Jr.**, S.M.'50, of Pittsburgh, Pa., on February 13, 1988, and **Bela B. Paine**, '52, of Brewster, Mass., in December 1986 have been reported; details are not available.

VI-A INTERNSHIP PROGRAM

As of October, 51 VI-A seniors were accepted in the MIT Graduate School to proceed on to the fifth year and Master's degree work. This number may increase in January, when others may be admitted on the basis of their work in the current fall term.

Two awards to VI-A alumni have come to my attention: **Mark A. Johnson**, '88, has been awarded a Charles LeGeyt Fortescue Fellowship by IEEE for graduate study; the fellowship honors Dr. Fortescue and his lifelong association with Westinghouse. And **William A. Radford**, S.M.'82, was co-author of a paper judged the best given at the 1987 IRIS (Infrared Information Specialty) meeting, an award announced at the 1988 IRIS meeting at Johns Hopkins. Bill is with the Santa Barbara Research Center.

Thanks to **Kenneth W. Conradt**, S.M.'87, I was invited to attend a "semiconductor outlook" conference held by Merrill Lynch at the Cambridge Marriott; Ken is in the investment banking end of Merrill Lynch at their New York City headquarters. His invitation was most fortuitous; in addition to hearing an interesting meeting, I met several other VI-A alums: **Peter M. Santusano**, '79, who is with the Boston venture capital firm of Hambro International Venture Fund; **Stephen Swerling**, '63 (with whom I had an enjoyable luncheon conversation), who is vice-president and co-founder of Mentor Graphics, Portland, Ore.; and **Louis R. Tomasetta**, Sc.D.'74, who is founder and president of a new company called Vitesse Semiconductor in Camarillo, Calif. Lou previously worked at MIT's Lincoln Laboratory with VI-Aer **Robert H. Kingston**, Ph.D.'51 (VIII), who is currently adjunct professor of electrical engineering in this department. Lou has a number of VI-As working for him and promised to send me a list.

On October 7, following the annual meeting of the Corporation, President **Paul E. Gray**, '54, and Mrs. Gray held a reception at the President's House for **Cecil H. Green**, '23, in honor of Cecil's and his late wife Ida's philanthropy to the Insti-

tute. This was the first anniversary of Ida's death and the 15th year of the Ida M. Green Scholars at MIT, of which she was so proud. This year's new scholars attended and were presented at the ceremony. It was my pleasure to hear once more from Mr. Green how much "good 'ole VI-A" has meant to him; as he recalled, it was through VI-A and his assignment at GE/Schenectady that Cecil met Ida.

One afternoon I had a surprise call from **Charles A. Kaminski**, E.E.'72. He told me he's now working with Baring America Asset Management Co., Inc., Boston, and that he has two children in his family.

While I was passing through the new Kendall Square complex one noon last fall, **Algis S. Leveckis**, S.M.'77, hailed me. Upon graduating from MIT he worked with Proctor & Gamble, but he's now with Index Systems, Inc., in Cambridge. During our conversation he told me that his classmate **Robert C. Sherrick**, S.M.'77, has completed his medical training and now is in practice as an M.D. in the Washington, D.C., area.

As part of my new departmental role, I've had a chance to visit several of our VI-A grads at the highly successful companies they've established. The first visit was with **Amar G. Bose**, Sc.D.'56, of the Bose Corp., Framingham, Mass., who still teaches the subject in acoustics (6.312) in our EECS curriculum.

Other business took me to Analog Devices, Inc., Norwood, Mass., and a meeting with founder **Raymond S. Stata**, S.M.'58, whose company I had the pleasure of adding to the VI-A Program in 1982. Another father-son combination to add to our VI-A roster: son **Raymie Stata**, '91, is currently a student with a VI-A assignment at Hewlett-Packard's Research Laboratory, Palo Alto.

H. DuBose Montgomery, S.M.'72, stopped by the VI-A office after attending his first meeting of the MIT Corporation, to which he was elected last spring. Following his chat with **Kevin O'Toole**, N.E.'57, VI-A director, DuBose and I discussed alumni relations and activities on the West Coast. DuBose is a partner in Menlo Ventures, Menlo Park, Calif.

Besides those mentioned above, **Deborah L. Rennie**, S.M.'86, signed our "guest book" while visiting from AT&T Bell Laboratories.—John A. Tucker, Special Assistant to Department Head, for VI-A, Room 38-473, MIT, Cambridge, MA 02139-3931.

VII BIOLOGY

Not much news this month, but two accolades to MIT from *Alumni Register* questionnaires may stimulate some discussion: From New York University, where she is professor of science education, **Cecily C. Selby**, Ph.D.'50, writes that MIT is "the least sexist academic environment I know," a place of "genuine equal opportunity. The leadership of women faculty and administrators at MIT is a source of enduring delight," she writes. Another important attribute, adds Selby: "MIT's ability to take leadership in special areas—for example, STS (science, technology, and society) and UROP—by taking end runs around lethargic faculty when deemed necessary." And "MIT puts its money where its rhetoric is!" adds Selby.

"Of all the institutions of higher learning I attended," writes **Matthew E. Highlands**, S.M.'34, from his retirement home in Orono, Maine, "MIT did more for me than any other—mentally, professionally, and in overall development." The faculty he knew were "most supportive and considerate in helping me with my education and future professional endeavors," writes Highlands, citing especially Deans Samuel C. Prescott, '94, and John W.M. Bunker."

James P. Lugo, Ph.D.'83, writes that he's attending the M.B.A. program at UCLA in preparation for starting his own company in the biotechnology field.

The Associated Press reported that MIT Profes-

sor **Jonathan A. King** had a leading role last fall in a Washington press conference by the Committee for Responsible Genetics. "Biological weapons are not like gunpowder or nuclear bombs," said King, according to the AP, "Biological agents can spread and reproduce." . . . **Elizabeth E. Quinn**, '90, whose MIT major is biology, has been honored with a \$1,000 Incentives for Excellence Scholarship from the National Science Foundation. The prize, given under NSF's Minority Graduate Fellowship Program, recognizes academic excellence.

The death of **Holbrook A. Bourne**, M.P.H.'41, in Windsor, Conn., on May 31, 1988, has been reported; no further information is available.

VIII PHYSICS

To **Michael Riordan**, Ph.D.'73, science information officer at the Stanford Linear Accelerator Center (SLAC), the 1988 science-writing award of the American Institute of Physics. The \$3,000 prize was for Riordan's book, *The Hunting of the Quark* (Simon and Shuster, 1987). . . . A gold award as the top chief executive officer for the forest products/lumber industry went in 1988 to **T. Marshall Hahn, Jr.**, Ph.D.'50, chairman and CEO of Georgia-Pacific Corp., Atlanta. Hahn was the choice of financial analysts and other forest industry experts interviewed by *The Wall Street Transcript*, who credited G-P with "outstanding profit performance" because "shareholder value always commands top priority."

Robert D. Haun, Ph.D.'57, formerly deputy chief scientist, is now chief scientist at Westinghouse Electric Corp., Pittsburgh. Haun joined Westinghouse's R&D Center when he finished his graduate work at MIT. . . . The academic life has lured **Daniel E. Murnick**, Ph.D.'66, away from AT&T Bell Laboratories; he's now professor of physics and chairman of the department at Rutgers University. Murnick moved his laser spectroscopy laboratory with him to Rutgers, and he'll also continue his activities as chairman of the American Physical Society's Committee on Applications of Physics and his work with APS' Education Committee, where he initiated a program for summer employment for high school physics teachers. . . . **Michael Kash**, Ph.D.'88, is now assistant professor of physics at his undergraduate alma mater, Lake Forest College, Lake Forest, Ill.

After postdoctoral fellowships at Stanford and the Weizmann Institute, **Allen I. Rubenstein**, Ph.D.'67, went to law school and is now a partner at Gottlieb, Rackman, and Reisman PC, New York, specialists in patent law. . . . From Muenster, West Germany, **James F. De Broux**, S.M.'79, writes that after nearly a year as the operations officer for the 570th U.S. Army Artillery Group, he has been advanced to the position of group executive officer. The group's mission is support for the 1st Belgian and 1st British Corps. De Broux was married on July 30, 1988, to the former Linda M. Archer.

MIT professor **Hale Bradt**, Ph.D.'61, is local chairman for the national meeting of the American Astronomical Society at MIT January 8-12, and **Eugene Mallove**, S.M.'70 (XVI), of the MIT News Office is press relations chairman. . . . From his home in Union Mills, N.C., **Eugene G. Sharkoff**, Ph.D.'53, writes that he is currently writing a physics laboratory manual for use in his classes at Isothermal Community College, Spindale, N.C., while completing a house that he has designed and built (with some subcontracting). Sharkoff's hobby: raising grapes and making wine for personal use. . . . **Arthur M. Vash**, S.M.'53, of Worcester, Mass., writes that his major hobby is flying; he owns two aircraft, a Beech Bonanza and a 1946 J-3 Cub on floats. He does many volunteer activities at the Boston Museum of Science, where his wife is a trustee. . . . **Jerome H. King**, S.M.'51, says he is now "winding down a bit" at his home in Palos Verdes Penin, Calif., working only part-time at R & D Associates, Marina del Rey, and "enjoying golf, travel, family,

and some reflection." Although he did not attend the U.S. Naval Academy, King held the ranks of rear admiral (1968) and vice admiral (1970) before retirement. "Both Yale and MIT served me well," he says. . . . Admiral **Robert H. Wertheim**, S.M.'54, has also retired for the second time after a distinguished career in the navy and at Lockheed. He now lives in a "lovely new home on the golf course at Rancho Bernardo, a suburb of San Diego," he writes. "But so far I've had less time than I'd like to enjoy the abundant amenities here due to the continuing commitments to a number of government advisory groups and committees and occasional work as consultant to Lockheed." . . . **Jay S. Howell**, S.M.'50, had a somewhat similar career: he retired from the navy in 1973 and from Raytheon Service Co., Arlington, Va., where he was lead engineer of the Command and Control Group, in 1985; he and Mrs. Howell now live in Silver Spring, Md., and devote their major efforts to volunteer activities.

Alvin E. Fein, Ph.D.'58, president of Fein-Marquart Associates, Baltimore, died on May 31, 1988. Fein worked for Westinghouse from 1956 to 1968, first at the Research Laboratory in Pittsburgh and later at the Defense and Space Center in Baltimore where his specialty was the application of computers to major research and development projects; he was instrumental in developing the NIH/EPA Chemical Information System, a collection of on-line, interactive modules for dealing with various aspects of chemistry.

IX BRAIN AND COGNITIVE SCIENCES

Michael Kuperstein, Ph.D.'82, has developed a prototype of the first "neural robot"—a machine that mimics human response to uncertainty by learning from trial and error. It's the fruit of research on neural networks at Kuperstein's company Neurogen, dedicated to R&D on neural network technology. Kuperstein is also the founder of Network Instruments to exploit his development (for his Ph.D. thesis) of a multiple channel brain probe to monitor communications between neighboring neurons.

MIT's Class of 1922 Career Development Professorship has been assigned to **Jeremy M. Wolfe**, Ph.D.'81, associate professor of psychology, to recognize his "innovative and imaginative teaching." Wolfe is in charge of 9.00—the large undergraduate subject, Introduction to Psychology, chairman of the committee for the interdisciplinary program in psychology, and a member of the Committees on Curricula, on the Independent Activities Period (IAP), and on the cognitive science major.

X CHEMICAL ENGINEERING

A major honor will come to Professor **Warren E. Stewart**, Sc.D.'51, of the University of Wisconsin in 1989: the American Chemical Society's Edgar V. Murphree Award in Industrial and Engineering Chemistry. . . . **Donald W. Wood**, S.M.'50, senior vice-president of Arco Chemical Co., Newtown Square, Pa., has a new additional assignment: president of Arco Chemical Asia Pacific, Inc., Hong Kong. . . . **George M. Keller**, '48, retires, effective January 1, as chairman and CEO of Chevron Corp., San Francisco; he's widely recognized as a leader in the West Coast business community and in the U.S. oil industry. . . . To recognize "long-term and continuous exemplary performance and significant contributions to Corning Glass Works, **Douglas R. Briggs**, S.M.'52, has been named a senior associate of the company. Briggs joined Corning in 1954 and since 1985 has been a project supervisor—standards in the Telecommunications Products Division. . . . At Lehigh University since 1984, **Harvey G. Stenger, Jr.**, Sc.D.'84, has been promoted to the rank of associate professor with tenure; his research is in reaction engineering and materials processing.

MIT's Energy Laboratory has a new director: Professor **Jefferson W. Tester**, Ph.D.'71, a 10-year member of the MIT faculty in chemical engineering. Tester is a specialist in geothermal energy development and petroleum production; he's been director since 1980 of the School of Chemical Engineering Practice. As Energy Laboratory director, Tester succeeds codirectors David C. White, Ford Professor of Engineering, and Malcolm A. Weiss, who will return to energy research and teaching assignments.

"Fundamentals of Static Control for the Electronics Industry" was the subject of **George R. Berbeco**, S.M.'68, at the International Conference on Modern Electrostatics in Beijing, China, last October. Berbeco is president of Charleswater Products, Inc., West Newton, Mass., maker of static control products. . . . From Edwin H. McCormick, S.M.'32: "Retired to Jekyll Island, Ga., in 1972. Built home; organized (and first president of) the Jekyll Island Men's Golf Association; became treasurer, then president of the Jekyll Island Arts Association, of which still director; director, secretary, and president of the Jekyll Island Lyons Club." . . . In addition to his job as senior consultant at Chesapeake Decision Sciences, San Anselmo, Calif., **Charles E. Bodington**, S.M.'54, serves the Sierra Club as national outings leader. . . . The work of **Shane S. Mohammadi**, S.M.'77, as senior research engineer at Union Oil Co. of California, Brea, has resulted in one patent; seven publications in enhanced oil recovery, mathematical modeling, heat transfer, and instrument design; and four software programs for point-of-sale applications. Mohammadi has served as a guest lecturer at the University of California, Berkeley, and in the continuing education program of the Society of Petroleum Engineers. At home in Irvine, Calif., his hobbies are business planning, scuba diving, and travel. . . . **John A. Feyk**, S.M.'50, who's with Aerospace Corp., Los Angeles, takes his running seriously: he finished 11th among men 60 and older in the 1988 Boston Marathon. . . . **Thomas W. Hastings**, Sc.D.'84, is senior chemical engineer at PQ Corp., Lafayette Hill, Pa. . . . As a research engineer at Amoco Research Center, Naperville, Ill., **Michael L. Thompson**, S.M.'84, is working on applications of artificial intelligence to chemical engineering and petroleum processing. Previous assignments have included mathematical process analyses, studies of the kinetics of epoxy resins and polymers, process modeling and optimization, and computer programming.

Recalling his career with Mobil Oil Corp., **Edward T. Maples**, S.M.'38, describes himself as a "wandering oil man." He spent nearly three years on Bahrain Island, running a refinery that made aviation gasoline for the China-Burma-India front in World War II; then lived two years in Rotterdam building a refinery, steam electric plant, docks, and housing. Next: project engineer of the Mersin Refinery in S.E. Turkey (to which he made 15 trips, including a three-month residency at the time of start-up). Thereafter Maples' travels increased: he was plant site inspector for Mobil installations in Taiwan, Singapore, Australia, and Europe.

What will you do when you retire? Here are some models to consider, from six respondents to the recent survey for the new *Alumni Register*. **Richard D. Packard**, S.M.'51, who lives in Cambridge, still has his MIT athletic card and maintains his interest in distance running (he finished four times—'58, '59, '61, and '62—among the top 25 in the Boston Marathon); he's also playing tournament bridge and plans to travel. . . . In Houston, **John Forgrave**, S.M.'50, has been "enjoying a life of increased travel, visiting with children and grandchildren, golfing and helping in the golf club management, and part-time consulting." He worked for 32 years at Exxon Chemical Co. . . . Retired from Rohm and Haas, **Enno T. Sauer**, S.M.'37, has been active in starting and developing Cedar Lake Lodge, a home for the mentally retarded. . . . After he retired as senior vice-president of General Electric Co., **Charles E.**

Reed, Sc.D.'37, has been following such personal interests as investments, personal computers, high-fidelity audio, and electronic organs. . . . **Joseph B. Marx**, S.M.'37, who worked at Hercules, Inc., now lives in Cherry Hill, N.J., where he is treasurer of the Presbytery of West Jersey, county coordinator for the American Association of Retired Persons (AARP), and active in AARP's tax aide program.

John B. Aaron, S.M.'47, died in Philadelphia on June 3, 1988; he was 68. Aaron was with DuPont from 1939 to 1978 and at Arco from then until retirement in 1984, specializing at both companies in evaluating new products and ventures. A 40-year resident of Swarthmore, Pa., Aaron was a member of the Swarthmore School Board from 1964 to 1974 and president for some of that period.

The deaths of **Carlos A. Gonzalez**, S.M.'43, in Lima, Peru, in 1983 and of **William L. Scarborough**, S.M.'33, in Advance, N.C., on June 30, 1988, have been reported; details are not available.

XI URBAN STUDIES AND PLANNING

Hotel planning and design are the specialty of **Walter A. Rutes**, '51, at 9 Tek, Ltd., development consultants, Scottsdale, Ariz. He holds the hotel industry's Platinum Circle Award for pioneering designs; is the author of SHAPE, a computer software program ("Strategic Hotel Applications for Project Evaluation") described as "the leading computerized system for space programming, cost estimating, and economic valuation of hotel and resort projects"; and consults on hotel projects worldwide. Rutes' first book, *Hotel Planning and Design*, is a definitive text for hotel designers and developers, and he's working on two new books on conference centers and resorts and leisure parks.

Professor **Bennett Harrison** of MIT is coauthor (with Professor Barry Bluestone of the University of Massachusetts/Boston) of *The Great U-Turn: Corporate Restructuring and the Polarizing of America* (Basic Books, 1988). The publisher describes it as a "devastating and meticulously documented critique of the 'laissez-faire affair' of the Reagan era," showing what can be done to reverse declining living standards and competitiveness that have resulted from outsourcing and reduced wages and opportunities of domestic labor. . . . Associate Professor **J. Mark Davidson Schuster**, Ph.D.'79, now holds a two-year MIT Cecil and Ida Green Career Development Professorship. Schuster is a specialist in arts policy, which he describes as "the ways in which government policies shape the arts and culture."

James B. Murphy, M.C.P.'83, is writing a thesis on the theory of the division of labor to complete his joint doctoral program at Yale in philosophy and political science. . . . **Camille Marie Ascuaga**, M.C.P.'85, is now studying in the Heller School at Brandeis under a Pew Fellowship. . . . From his desk in Massachusetts' Division of Capital Planning and Operations where he is deputy director of a special unit on corrections, **Thomas J. Nally**, M.C.P.'77, writes: "With current MIT faculty and 12 other recent graduates, I'm a member of the DUSP curriculum focus group in design and development, convened in January 1988 by **Dennis Frenchman**, M.C.P.'76. Our assignment is to help the department evaluate and reshape components of its curriculum. It feels good to be part of that process, a worthwhile opportunity for local alumni to contribute to the department's future." Because of this and other commitments, says Nally, he has less time than he'd like to serve on the volunteer faculty of the Boston Architectural Center. . . . **Jonathan Warner**, M.C.P.'86, has been promoted to associate at Sasaki Associates, Inc., Watertown, Mass.

From West Palm Beach, Fla., where she is community development director, **Shirley Drumbo Simpson-Wray**, M.C.P.'77, writes that she has re-

ceived her AICP certification and hopes to begin a small consulting business in planning and development in South Florida "in the near future." . . . **Marion E. Langstaff**, M.C.P.'51, has retired in Seattle with enough interests to keep her busier than ever—bicycling, hiking, bird watching, gardening, environmental affairs. She is a member of Seattle Mountaineers, National Campers and Hikers, Washington Environmental Council, and Puget Sound Alliance, and she is a volunteer worker with the U.S. Forest Service in camp-ground maintenance, trail building, etc.

XII EARTH, ATMOSPHERIC AND PLANETARY SCIENCES

Since last August 1, **James Powell**, Ph.D.'62, has been president of Reed College, Portland, Ore. Following his doctorate in geochemistry at MIT, Powell joined the faculty at Oberlin, where he rose to become acting president in 1982. Then he moved to Franklin and Marshall College to be president for five years, during which he won campus acclaim and alumni anger for disbanding the school's fraternity system after a stipulated reform in behavior did not occur.

Associate Professor **Jack Wisdom** has received tenure at MIT. A graduate of Rice and Caltech, Wisdom came to MIT in 1985 and since then has won two major prizes of the American Astronomical Society—the Harold Urey Prize in 1986 and the Helen B. Warner Prize in 1987. Wisdom's research is in the field of orbital dynamics, and he's credited with important discoveries about meteors and asteroids.

From Laguna Beach, Calif., **William B. Farrington**, Ph.D.'53, recalls that he received his doctorate after 20 months at MIT. "Most of the graduate students thought I had busted out when I said good-bye, as they figured I had just arrived," he writes. But there's another side to that coin: "One does not make many friends as a graduate student who intends to get a Ph.D. as fast as possible," observes Farrington. . . . **Julius Honig**, S.M.'53, has changed careers, leaving IBM to become head of the Information Systems Department, Golden Gate University, San Francisco. He finds education "a complete change . . . a new set of challenges." . . . **John H. Carlson**, '83, is managing director at the Security Pacific Merchant Bank, responsible for risk management and tax-exempt products. . . . In Santa Clara, Calif., **Richard C. Deininger**, Ph.D.'83, is a technical partner in the Deskin Research Group, a job that leaves him time for masters ski racing in the Far West Division, USSA. . . . From Carmel, Calif., **Glyndon L. Lynde**, S.M.'52, writes that he is "fully retired," swims and golfs five times a week. . . . **David Atlas**, Sc.D.'55, retired from NASA in 1984 and is now doing independent research on air-sea interactions, radar meteorology, and rainfall measurement by spaceborne remote sensors, the latter involving a joint mission with Japan under contract with NASA. He's also editing proceedings of the 40th radar meteorology conference, and in his spare time swims, plays tennis, travels, and enjoys the company of three great-grandchildren. . . . **Ross E. Voyles**, S.M.'53, retired from the air force in 1982 and since then has engaged in a real estate investment business in Santa Clara, Calif.

The deaths of two meteorology alumni have been reported, but details are not available: **Barry A. Mendoza**, '58, of La Mesa, Calif., on July 5, 1986, and **Clayton D. Wright**, S.M.'53, of Las Cruces, N.M., on March 12, 1986.

XIII OCEAN ENGINEERING

From Naples, Italy, Lieutenant Commander **Richard A. Schwarting** (U.S.N.), Oc.E.'83, wrote early in the summer that he is salvage officer for the Mediterranean and Persian Gulf. His then-most-recent project: "Salvage of U.S. Marine helicopter lost on 18 April 1988 off the Iranian is-

land of Abamusa during night action following navy retaliation against Iran." . . . From Captain **Peter B. Bowman** (U.S.N.), Oc.E.'73: "I'm the shipyard commander (the boss!) at Portsmouth Naval Shipyard, an 8,000-person installation overhauling nuclear submarines in southern Maine. Tough but rewarding job!"

Captain **Mario G. Vangeli**, S.M.'34 (U.S.N. Ret.), died on March 9 in Naples, Fla., from kidney failure following surgery. Before his retirement in 1957, Vangeli, a native of Italy and an Annapolis graduate, served in Central and South America, at the Boston and Fore River shipyards, and in the South Pacific during World War II; he witnessed the surrender ceremonies on the U.S.S. *Missouri* in Tokyo Bay in 1945. Later he was assigned to the American Embassy in Rome, and following retirement he remained in Rome for four years as president of European Raytheon. Thereafter he and Mrs. Vangeli lived in Washington, D.C., before moving to their retirement home in Naples in 1982.

From **James A. Schmicker**, S.M.'86: "I have accepted a position as naval architect with Bruce Farr & Associates, Inc., of Annapolis. I will be responsible for the structural design of ocean racing yachts—and also for computer predictions of the yachts' performance."

Associate Professor **Paul D. Sclavounos**, Ph.D.'81, has received tenure on the MIT faculty. Sclavounos' research is on water waves and their interactions with ships and offshore platforms, and his theoretical work has "pushed the state of the art in numerical analysis and set a new industry standard," said the department in recommending tenure. Sclavounos studied at the National Technical University of Athens before coming to the U.S., and he was a postdoc at MIT for two years before joining the faculty.

News of retirement activities dominates the information supplied on *Alumni Register* questionnaires. **F. Avery Packer**, N.E.'51, retired from the navy 21 years ago and from Exxon 5 years ago; now he's adjunct professor of mathematics at Kean College, Union, N.J.—"part-time work that is just right for me," he writes. . . . "Following my retirement as a captain in the coast guard in 1970," writes classmate **Austin F. Hubbard**, N.E.'51, "I attended seminaries and was ordained as a priest in the Episcopal Church. I have served as assistant, associate, and rector of a number of churches. My specialty is holding services for the deaf in sign language. I am currently serving as a semi-retired assistant at St. Mary's Episcopal Church and interpreting for the deaf at St. Paul's Roman Catholic Church, both in Daytona Beach."

Captain **Jack A. Obermeyer**, S.M.'41, USN (Ret.), died in Stamford, Conn., on July 25, 1988. He had retired from the navy in 1968 and from his post as manager of government and industry relations in the Marine Department of Texaco, New York City, in 1985. Obermeyer's naval career included several important assignments, including commanding officer and director of the David Taylor Model Basin and commanding officer of the U.S. Naval Ship Repair Facility in Yokosuka, Japan. A resident of Darien, Conn., Obermeyer was a member of the Darien Senior Men's Association, the Darien Kiwanis Club, and the Noroton (Conn.) Presbyterian Church; he was also active in SNAME, the Society of Naval Engineers, the National Council of the Boy Scouts of America, and other national groups.

The deaths of **Arnold E. Jakel**, S.M.'44, during emergency heart surgery in Madison, Wis., on July 15, 1988, and of Commander **Thomas V. Norman, Jr.**, N.E.'58, USN, of the Naval Ship Systems Command, in Severna Park, Md., on August 2, 1986, have been reported; further details are not available.

XIV ECONOMICS

Less than a year after the event, **David McClain**, Ph.D.'74, is in print with a book that Professor

Charles P. Kindleberger of MIT calls ". . . a first-rate interpretation of the origin, course, and likely consequences of the New York Stock Exchange meltdown of October 19, 1987." McClain is chairman of the Department of Finance and Economics of the School of Management at Boston University; he warns in his book, *Apocalypse on Wall Street* (Dow Jones Irwin, 1988), that sweeping financial and economic reforms are necessary to ensure against an economic catastrophe similar to the aftermath of the 1929 stock market crash.

Reviewing prospects for the new administration of President Carlos Salinas de Gortari in Mexico, author James Dorsey in *The World & I* (September 1988) says that **Pedro Aspe Armella**, Ph.D.'78, is expected to play a "key role" as planning minister. Aspe is expected to continue the previous administration's "pragmatic economic policies aimed at privatizing the economy, opening the country to foreign investment, and paying interest on the \$107 billion foreign debt," writes Dorsey.

From Arlington, Mass., **Vincent A. Fulmer**, S.M.'63, writes a glowing tribute to MIT in his *Alumni Register* questionnaire. "The Institute's basic orientation to the future and its willingness to embrace change without discarding what is good, decent, and worth preserving from the past allow MIT to do remarkable things not possible or practical elsewhere," he says. Indeed, writes Fulmer, "these basic qualities are its crowning glory. . . . When has anyone remotely connected with the Institute not felt spiritually uplifted and microscopically close by simply taking the time to think about MIT?"

Thomas Q. Gilson, Ph.D.'54, retired in 1983 after 30 years' combining labor arbitration with teaching in the field of personnel and labor relations. Now he continues labor arbitration from his home in Seattle.

Horace H. Squire, Ph.D.'62, associate professor of economics at the University of Vermont, died at his home in Burlington, Vt., on December 26, 1987; further details are not available.



Ed O'Hara

XV MANAGEMENT

From **Christopher S. Bacon**, S.M.'87: "I've been in Minneapolis since January, working at General Mills in marketing research. My primary duties are to develop marketing applications for GM's tracking information from A.C. Nielsen; I'm building regression models to try to explain marketing actualities—and I hope I'll have the success John Little has had. . . . **David G. Benson**, S.M.'67, should win a prize of sorts for this report from England: he is now group managing director of Voyager Group Ltd., which he describes as "a private company owned by British entrepreneur Richard Branson. My portfolio includes Virgin Atlantic Airways, a holding company, a fashion model agency, and a retail concern selling products from the wool of black sheep!" . . . Professor **John E. Van Maanen** of MIT is the author of *Tales of the Field: On Writing Ethnography* (University of Chicago Press, 1988); it's a survey of how writers describe culture and styles of corporate life. . . . *High Performance Planning* (Kansas City: Management and Industrial Research Publications, 1988) is a new title from **Richard Muther**, S.M.'41, president of Richard Muther and Associates. The subtitle tells it all: *A Basic Approach to Planning*.

MIT Professor Emeritus **Richard D. Robinson**, Ph.D.'63, is the author of *The International Transfer of Technology: Theory, Issues, and Practice* (Ballinger, 1988), a book that—according to the publishers—"offers for the first time an overall model of international technology transfer, an integrated summary of relevant research and practice, and in-depth analyses of major issues from 'brain drain' to 'appropriate technology'." Robinson founded the program in international management at MIT; having retired from the Institute, he is the George F. Jewett Distinguished Professor of Business at the University of Puget Sound, Tacoma, Wash.

Three members of the management faculty have received tenure at MIT: **Chi-Fu Huang**, associate professor of finance; **Thomas W. Malone**, Thomas Drane Career Development Associate Professor in Information Technology and Management; and **Garth Saloner**, associate professor of applied economics. All three hold Ph.D.s from Stanford, and Huang and Saloner came to MIT immediately after completing their graduate work. Malone, whose teaching and research are in human-computer interaction, was a research scientist at the Xerox Palo Alto Research Center from 1980 to 1983. Economists Huang and Saloner are working, respectively, in financial economics and the application of dynamic game theory to industrial organization.

James L. Monroe, S.M.'85, is now president of Boylston Capital Corp., Newton, Mass.; he was formerly a corporate finance associate at L. F. Rothschild & Co., New York. . . . **C. Lawrence Meador**, S.M.'72, is president and CEO of Decision Support Technology, Cambridge; as sponsor, he shared the platform at an executive briefing on "Implementation Strategies for Expert Systems" in Chicago and Cambridge in November. . . . After four years as Israel's ambassador to the United Nations, **Benjamin Netanyahu**, S.M.'76, who attended MIT as **Benjamin Nitay**, is back in Israel and running for office; he was the leading vote-getter last July in balloting to represent the right-wing Likud bloc in late fall parliamentary elections. . . . **Jonathan J. Golovin**, Ph.D.'75, is chairman of the board of Consilium, Inc., Mountain View, Calif., specializing in factory floor management systems. He was keynote speaker at a University of Rochester (Simon School of Business Administration) conference on "Beyond MRP-II: Evolution to a New Standard" last fall.

James M. Kaufman, S.M.'83, is a commodities trader with Philipp Bros., Inc., New York—"everything from soybeans to silver," he writes. "When not trading options, I enjoy life in suburban Long Island (Centerport) with my wife Anne and our basset hound 'Carling'. Twelve-hour days plus commuting only leave time for weekend gardening as a hobby." . . . In addition to working at Arthur D. Little, Inc., **Jeffrey C. Wickham**, S.M.'84, is a field representative for Earthwatch, a nonprofit organization matching volunteers and funds to scientific research projects worldwide. . . . A progress report from **Paul H. Levy**, S.M.'77, who started Sterilizer Technologies Corp. in 1986: "The product has been certified and is being actively marketed to hospitals and laboratories. The product line is being expanded, and we expect sales to exceed projections." . . . From her home in Seattle, **Patricia E. Grossman**, S.M.'85, reports that she is a specialist in employee-owned business and community revolving loan funds.

Recollections from the 1930s: **Howard Lendering**, S.M.'32, retired from Du Pont, remembers that as a graduate student he worked in Walker Memorial for both room and board, and half of his student aid loan was cancelled when his grades were satisfactory. In retirement, Lendering has helped "in a minor way" with the mentally handicapped in Martinsville, Va. . . . During the first year of retirement from RJR Archer, Inc., **Richard B. Gillett**, S.M.'52, Winston-Salem, N.C., writes that he has traveled in the U.S., Europe, and the West Indies and has increased his activities with the Moravian Church and other community groups. . . . **Ralph W. Van Sant**,

S.M.'36, retired from Gulf Oil Corp., is a past president of the home owners' association in Sequim, Wash.

Sloan Fellows

Travelers on Northwest Airlines had a special introduction to **Colby H. Chandler**, S.M.'63, courtesy of Northwest's in-flight magazine *Sky* last September. As chairman and CEO of Eastman Kodak since 1983, Chandler has presided over "a massive remaking of the century-old company," says author Jeffrey Zygmont. From it Kodak "has emerged with a wholly new, more responsive management structure. It has shed businesses that didn't mesh with its vision of future growth. It has even entered some vast new markets, most notably through the \$5.1 billion acquisition in January (1988) of Sterling Drug."

Charles E. (Ed) O'Hara, S.M.'81, is now superintendent of Union Pacific Railroad's Nampa, Idaho, Service Unit, responsible for day-to-day UP operations between Nampa and Hinkle, Ore.—a total of 842 miles of track. O'Hara was superintendent of the Nebraska Division in 1986 and in 1987 was named consultant in operating planning research. . . . Mitre Corp., Bedford, Mass., has named **Robert E. Smylie**, S.M.'67, technical director of its Space Systems Division, of which he has been associate technical director. The new job means that Smylie is responsible for all of Mitre's work for NASA in satellite and ground communications and information systems. . . . Formerly director of telecommunications marketing planning at IBM, White Plains, N.Y., **Nan G. Lower**, S.M.'84, is now a principal at Ernst & Whinney, New York; her assignment is national director of the company's financial services industries consulting unit.

Carl D. (Pete) Peterson, S.M.'72, who runs his own business brokerage business, is the author of *How to Leave Your Job & Buy a Business of Your Own* (McGraw-Hill, 1988). According to the publisher, Peterson has worked with more than 3,000 business seekers whose firsthand experience is the basis for the book, which covers everything from how to leave your former employer to what to do as a new owner. . . . "Women's Work, Women's Worth" was the title chosen by Sister **Mary Norberta (Malinowski)**, S.M.'80, for an address to the Mid-Coast Branch of the American Association of University Women in Rockland, Maine, last spring. Sister Mary Norberta has been president and CEO of St. Joseph Hospital, Bangor, since 1982 and executive vice-president of St. Joseph Healthcare Foundation since 1983.

A silver tray to express the National Executive Service Corps' gratitude came to **Herbert Kay**, S.M.'68, of Greenwich, Conn., last summer. Kay, retired corporate vice-president of Amax, Inc., is vice-president of the service corps' Math/Science Education Group, and he was honored for designing programs to prepare retired professionals for second careers as teachers. . . . From his office as president of Psychiatric Medicine Associates, Billerica, Mass., **Michael H. Nelson**, S.M.'77, writes that he is "enjoying hugely steering my mom-and-pop medical/psychiatric practice through the flux of institutional changes in the health care industry—a sea full of corporate sharks. Designing my market niche while maintaining quality control, designing institutionalized ways to keep malpractice lawyers at bay, and providing good care, all the while taking the risk of corporate expansion—neat trick if you can do it!"

Joseph T. Cosby, Jr., S.M.'40, who retired more than a decade ago to Smoke Rise, Butler, N.J., after a management career with Metropolitan Life Insurance Co., died on April 27, 1987; further details are not available.

Management of Technology Program

In Belmont, Mass., **Dennis J. Fogarty**, S.M.'88, has a new addition to the family: Jillian Albright was born June 16. . . . **Kathy Kessel-Hunter**, S.M.'88, is now technical marketing manager with

ICAD, Cambridge. . . . **A. Radford Laney**, S.M.'88, is in Houston, a project engineer with Schlumberger Well Services. . . . Back from Japan, **Hiro Yamazaki**, '88, has started work as general manager for the American branch of Nippon Zeon, White Plains, N.Y.

As manager of strategic planning for Varian's Electron Devices Group, Palo Alto, Calif., **Eric Schmidt**, S.M.'87, has put his MIT lessons to work. He says he has redesigned the corporate planning process to focus more on external factors, especially customer needs and the competition. And he says he and Lorraine have settled into the California lifestyle; they were expecting their first child on Halloween.

At Sanders Associates, Inc., Nashua, N.H., a Lockheed company, **Jay Herther**, S.M.'86, is deputy manager for a prototype integrated electronic warfare systems (INEWS) for the advanced tactical stealth fighter. He and Dianne had their first child, Jamie Lynne, on Friday, May 13, 1988. Jay writes that he spends spare time sailing his Cape Cod Bullseye and wishes it had enough room for a playpen! . . . **Anthony F. Purdie**, S.M.'86, is technical manager with Living Technologies, Ltd., Clydebank, Scotland. . . . From Everett, Wash., **Katherine Rowe**, S.M.'86, reports that she has a new assignment reporting to the vice-president—R&D at Physio-Control Corp., Eli Lilly & Co., Redmond, Wash.: to shorten product development cycles and implement quality programs and new technologies in engineering. Toward that end, she says, she's doing a lot of traveling. Husband Steve is now working as a composite materials specialist for the Federal Aviation Administration, Seattle.

Eugene W. Huang, S.M.'85, was recently married to Pamela Ann Goehring in Wyckoff, N.J.—Cheryl Kelliher, Room E52-125, MIT, Cambridge, Mass. 02139.

Senior Executives

We read in the papers that **Raymond E. Galvin**, '77, formerly vice-president for its Eastern Region in New Orleans, is now senior vice-president of Chevron USA, San Francisco. . . . **William E. Crain**, '82, senior vice-president of Chevron USA, is now also vice-president—exploration and production and a director of Chevron Corp., San Francisco. . . . **Robert C. Perry**, '63, has retired as president of PPG Europe/PPG Industries International, Paris. . . . **Edward E. Barr**, '69, president and CEO of Sun Chemical Corp., Fort Lee, N.J., is now also president and CEO of Dainippon Ink and Chemicals, Americas, Inc., Fort Lee; both firms are subsidiaries of Dainippon Ink and Chemicals, Inc. . . . **Gregory C. Plakias**, '86, formerly Digital Equipment Corp.'s manager for storage manufacturing, is now storage manufacturing vice-president. . . . **Robert H. Denien**, '83, is now president of LLV Division of Grumman Corp., Montgomery, Pa.; he was vice-president—integrated logistic support at Grumman Aircraft Systems Division, Bethpage, N.Y. . . . **Ronald J. Paparella**, '80, has moved from Petersburg, Fla., where he was president of US Gold Corp., to be president of Towle Silversmiths Division, Towle Manufacturing Co., Newburyport, Mass.

The Alumni Association has been informed of the deaths of **Dale A. Griffith**, '75, in Kalamazoo, Mich., on February 16; **Louis C. Habegger**, '60, in Uerikon, Switzerland, in April; and **George H. Pace**, '68, on June 5 in Cleveland, England; details are not known.

XVI AERONAUTICS AND ASTRONAUTICS

Technical equipment to improve the operation of three wind tunnels used for student projects in the department has been given to M.I.T. by General Electric. The gift included three variable-speed drives, one of 200 hp and two of 25 hp, and associated equipment. No cash value was stated. A touch of drama was added when, by coinci-

dence, the new material arrived in Cambridge just two days after an obsolete motor, due to be replaced, had been broken down.

Contributions by two alumni are included in *Outlook for Commercial Supersonic and Hypersonic Transport Aircraft*, circular number 333 of the Transportation Research Board (July 1988): **Ben H. Lightfoot**, '56, of Northwest Airlines writes on "A Market for the Orient Express," and **Albert W. Blackburn**, S.M.'52, of the Federal Aviation Administration on "High-Speed, Cruise Environmental Concerns."

Robert C. Uddenberg, S.M.'37, who was affiliated with the University of Southern California's Institute for Safety and Systems Management, died on March 17 at the age of 72; further details are not available.

To **Charles W. Ellis**, S.M.'52, the American Helicopter Society (AHS) 1988 Klemin Award for "noteable achievement in the advancement of rotary-wing aeronautics." Ellis is vice-president—business acquisition and helicopter program management at Boeing Helicopters, Philadelphia. He's past president, past chairman, past technical director, and honorary fellow of AHS and has held major management positions at Boeing Helicopter since 1965.

Lieutenant General **John M. (Mike) Loh**, S.M.'73, is commander of the Aeronautical Systems Division, Wright-Patterson Air Force Base; he's been vice commander since January 1987 and is a veteran of 28 years of Air Force service. . . . **Stuart Kazin**, S.M.'67, has been advanced to vice-president—manufacturing and distribution at Lotus Development Corp., Cambridge. . . . **Larry W. Barstow**, S.M.'86, is a manufacturing development engineer at Hewlett-Packard, Andover, Mass., with responsibilities that include the design and installation of instrument assembly systems; he spoke on the use of simulation to improve manufacturing efficiency for the Merrimack Valley Section, IEEE, last fall. . . . Formerly associate professor of management at Boston University, **Efrem G. Mallach**, Ph.D.'69, is now on the faculty at the University of Lowell. . . . **Holt Ashley**, Sc.D.'51, has been reelected to the Council of the National Academy of Engineering. . . . On the faculty at California State University, Northridge, **Melvin Epstein**, S.M.'53, is specializing in computer-generated graphics and animation. His film "The Spark" was shown on PBS and other outlets (including Norwegian television) and has been selected for the Museum of the Diaspora, Israel.

Responses to the *Alumni Register* include news of four retirees: Captain **John T.S. Kearns**, S.M.'53, USN (Ret.), is mayor of Culpepper, Va., a sometime columnist for the local papers, and active in the Virginia Society and the Municipal Power Association of Virginia. . . . Since retiring to Santa Barbara, Calif., **Horace R. Byers**, Sc.D.'35, has been a member of the board of the Affiliates of the University of California, Santa Barbara, and other civic affairs. . . . From Lansdale, Pa., **Donald N. Spangenberg**, S.M.'55, reports that he has spent two three-month assignments (1985 and 1986) as a missionary in Kenya. . . . Having retired from Sikorsky Aircraft, **Miller A. Wachs**, S.M.'35, is an active member of the Methodist Church and the "Beyond War" movement in Stratford, Conn., where gardening is his hobby.

Surveying the careers of former astronauts at the time of the September Discovery lift-off, Knight-Ridder newspapers found consultant **Edwin (Buzz) Aldrin**, Sc.D.'63, living in Laguna Beach, Calif., with his wife, Lois Driggs Cannon, of less than a year. At first, said the new Mrs. Aldrin, she thought of her husband's time in space as "just a job," which is how Aldrin was trained to think of it. But then, said Mrs. Aldrin, she realized that they were married on Valentine's Day. "Anyone who would go to the moon would be romantic," she decided.

A major new award honors the memory of Institute Professor **Charles S. Draper**, '26, former head of the Department at MIT. To be awarded

for the first time in October 1989, the Draper Prize of the National Academy of Engineering (NAE) will recognize engineering and technology achievements "contributing to the advancement of human welfare and freedom." NAE's selection committee for the first Draper Prize is chaired by **Robert C. Seamans**, Sc.D.'51, senior lecturer at MIT, and includes **Solomon J. Buchsbaum**, Ph.D.'57 (VIII), executive vice-president of AT&T Bell Labs, **Daniel I.C. Wang**, S.M.'61 (XX), professor of biochemical engineering at MIT, and **Shiela E. Widnall**, Sc.D.'64, Abby Rockefeller Mauze Professor at MIT.

XVII POLITICAL SCIENCE

Rhonda J. Crane, Ph.D.'77, of AT&T's Washington office played a big part in organizing the MIT symposium on world communications policy in honor of the late Professor **Ithiel de Sola Pool** in 1987; now she's received the AT&T Public Affairs Award for that effort. . . . After 15 years in conservation and planning for the state of Maine, **Richard E. Barringer**, Ph.D.'68, has become director of the graduate program in public policy and management at the University of Southern Maine, Portland. Barringer was the first director of the Bureau of Public Lands of the Maine Department of Conservation in 1973, and before taking his new university job he was commissioner of conservation and state planning director. . . . **Colleen A. Dunlavy**, Ph.D.'88, is assistant professor of history at the University of Wisconsin, Madison, and **Paul Josephson**, Ph.D.'87, has a similar appointment at Sarah Lawrence College.

A tribute to the pioneering MIT-Japan Science and Technology Program from the Congressional Office of Technology Assessment (OTA) in Washington: OTA asked the MIT program, which was founded by Professor **Richard J. Samuels**, Ph.D.'80, how its experience might serve as a model for other universities who want to prepare their students and faculty for greater interaction with their Japanese counterparts.

Jose Agustin Silva Michelena, Ph.D.'68, died in Caracas, Venezuela, in August 1986; details are not available.

XVIII MATHEMATICS

Two of three Leroy P. Steele Prizes given at the centennial of the American Mathematical Society came to members of the MIT faculty. Professor **Sigurdur Helgason** won the 1988 Steele Prize for Expository Writing, Professor **Gian-Carlo Rota** the 1988 Steele Prize for a Fundamental Paper. Helgason was cited for his books, *Differential Geometry and Symmetric Spaces* (1962), *Differential Geometry, Lie Groups, and Symmetric Spaces* (1978), and *Groups and Geometric Analysis* (1984), Rota for a paper on the theory of mobius functions.

Associate Professor **Anthony T. Patera**, Ph.D.'82, has received tenure on the MIT faculty (mechanical engineering). . . . Following two postdoc years at the University of California, Berkeley, **Daphne Smith**, Ph.D.'85, is assistant professor of statistics at the University of Georgia, Athens. . . . At the University of Massachusetts, Amherst, **David A. Mix Barrington**, Ph.D.'86, is busy building a research group in the theory of computation. Among the new arrivals is **Seth M. Malitz**, Ph.D.'88. . . . **David A. Castanon**, Ph.D.'76, is senior scientist at ALPHATECH, Inc., Burlington, Mass., working in various areas of stochastic control, team theory, and estimation with applications to strategic defense systems. He spoke on "Dynamic Weapon Target Assignment Algorithms" at a fall 1988 meeting of the Control Systems Chapter, Boston Section, IEEE.

From Weston, Mass., **Janice Rossbach**, S.M.'51, writes that she and her husband are looking forward to retiring to Maine; she's been associated with GTE for 25 years, currently as a systems en-

gineer, GTE Government Systems, Needham, Mass. . . . **Robert F. McIntosh**, S.M.'51, formerly of Software Corp. of America, Herndon, Va., makes retirement sound appealing: "Currently living aboard a sailboat with my wife Mary and expect to continue drifting for the next several years."

XXI HUMANITIES

On leave from General Electric, Wilmington, Mass., **Frank Emspack** is project director at the Center for Applied Technology of the Massachusetts Centers of Excellence Corp. The center's goal is to accelerate technology development and transfer in the state by providing small companies with technical services that until now only larger firms could afford. As a member of the board of IUE Local 201 in 1979, Emspack was the first labor fellow in the Program in Science, Technology and Society (STS) at MIT.

Four students entered the new Ph.D. program in the history and social study of science and technology in STS last fall—a "major new venture" for STS, says Professor **Kenneth Keniston**, director.

Two members of the humanities faculty have received tenure at MIT: **Peter C. Perdue**, Ford International Associate Professor in history, and **Suzanne Flynn**, associate professor of second-language acquisition. Perdue, at MIT since 1980, is a specialist in Chinese and Japanese history, fluent in both languages, and honored for his teaching. Flynn is a Cornell linguistics graduate who has been at MIT since 1981.

XXII NUCLEAR ENGINEERING

Eduardo Testart, S.M.'81, is doing research on materials at the Chilean Commission for Nuclear Energy. He is also working at a magazine called *Technologia Industrial* and would welcome submissions. . . . **Chang M. Kang**, Sc.D.'72, left S. Levy Inc. in 1987 and is now president of Advanced Energy Technology, which provides technical consultation for power utilities and research organizations.

James K. Liming, S.M.'83, reports from Fountain Valley, Calif., that he is an engineering and management consultant at Pickard, Lowe, & Garrick, Inc., Newport Beach, making risk and reliability analyses for an international clientele. . . . At the University of Miami, Professor **Sadik Kakac**, S.M.'60, is now the graduate director of the Department of Mechanical Engineering.

Since he finished his work at MIT, writes **Carlos Villanueva-Moreno**, Nu.E.'77, he has been head of the Nuclear Engineering Department at Comision Federal de Electricidad, Mexico's national utility that owns—among other facilities—the Laguna Verde nuclear plant. Villanueva-Moreno was elected to the Mexican Academy of Engineering in 1986, and starting in 1987 he's been a consultant to the International Atomic Energy Agency in the field of nuclear fuel management.

TPP TECHNOLOGY AND POLICY PROGRAM

Stephen Korthals-Altes, S.M.'86, is now working with Orbital Sciences Corp., Fairfax, Va. . . . **Dwayne Breger**, S.M.'83, is studying for a Ph.D. in resource economics at the University of Massachusetts, Amherst. . . . **Seth Tuler**, S.M.'87, is working with the Center for Technology, Environment, and Development at Clark University, Worcester, Mass. . . . From London, **Richard Davies**, S.M.'84, reports that he is now a writer for *The Economist*, covering industry and trade union issues for the "Britain" section of the magazine.—Richard de Neufville, '60, chairman, Room E40-252, MIT, Cambridge, Mass., 02139.



CLASS NOTES

17

This month's notes are in two parts: the inevitable announcements of the passing of classmates and others; and some news of current activities of others of your classmates.

There is a famous line "any man's death diminishes me . . ."; the sudden passing of our class president, **Stan Dunning**, is for me—as I know it will be for all who read this—a poignant reminder of this quotation.

Several days ago I had written for these notes that in late August the Severances visited Stan at Havenwood in Concord, N.H. We had vacationed in Nova Scotia and enjoyed comparing notes with Stan on lots of places there for which he carried many happy memories from his years while working in Canada. Others who had visited Stan included relatives, friends from Boston's Old South Church, from the M.I.T. campus, and from The Skating Club of Boston. Some of you may recall that Stan's figure skating included ice dancing.

Again we enjoyed still another visit September 9, but now I must report that two days later he quietly passed away at age 94. We shall remember Stan for his devotion to MIT and our class: 40 years as an elected officer of the class (president since 1977), MIT Club officer, chairman of Alumni Association committees and member of its executive committee. In the words of his Bronze Beaver citation, he was "a constant, effective and loyal contributor to the advancement of MIT."

At the Memorial Service at Havenwood Retirement Community in Concord, N.H., many had their own memories to share: Havenwood residents, family from as far away as California, the pastor (and others) from Boston's Old South Church where Stan was historian and in other ways active for years, and the pastor of a nearby church whom Stan had known since she prepared for the ministry and who participated in the service.

Not having received any news from classmates, I called a couple. **Penn Brooks** is still active at his farm in Virginia and sounded as robust as when he had been developing MIT's Sloan School of Management as its first Dean, and when he kept us all on our toes as chairman of the committee responsible for the ceremonies on the occasion of Jay Stratton's inauguration as MIT's 11th president. Penn expects to visit Boston again soon.

At the end of August I called **Ray Brooks** for news. By the way, if any of you have news but find it a lot easier to use the phone than to write me, just call (617) 237-9378, or send me a card with your telephone number and I'll call you.

First, let me say that Ray, your World War I Ace, is far busier than most of us. That night he was going to a bash of 95 commercial aviators. Four days before he was flown by a good friend to a full day's air show in Sussex, N.J., where for the third consecutive year he was put on the public address system. He hadn't decided to take in a Labor Day picnic with a local U.S. Air Force association because that was to be followed by

four days as guest at another big gathering at Atlantic City. Needless to say he's following the fate of the long-postponed flight of space shuttle *Discovery* and hopes to be at its lift-off long before you read these notes. He is still active with the Quiet Birds and the Gathering of the Eagles (what a who's who list of aeronautic "greats").

Needless to say, he constantly meets people you and I only read about.

As the kids say, that's the good news. In brief, he's busier than ever, including interviews on television for the press (*N.Y. Times*)—and grateful for a long and satisfying life. On the other side of the coin, there were those 23 times in the hospital and for a decade his eyesight has deteriorated to the point he can read nothing smaller than one-half inch type. And, like so many, he is dependent on others to do his reading and writing, and on aides and wheelchair to get around. How fortunate so many able-bodies pilots take him in hand—even to have him fly their private planes with them! Keep it up, Ray!—**Don Severance**, Acting Secretary, 39 Hampshire Rd., Wellesley, MA

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I am reaching the low point in news from classmates. The one letter was a copy of a report by **Herbert Larner** that he wrote to his golf club in New Jersey with respect to geese—who are no respectors of cleanliness of the environment.

My latest statistic for 1918 shows 35 graduates and 28 widows still on the mailing list. How about a special effort to send me news—what you are doing and how your MIT training helped you in this century.—**Max Seltzer**, Secretary, 865 Central Ave., Needham, MA 02142; **Leonard I. Levine**, Assistant Secretary, 519 Washington St., Brookline, MA 02146

19

Our class notes this issue are not many but all good. A recent poll of the class suggests that we may have an official 70-year reunion. Your committee, however, decided to wait a little longer to hear from more class members after which a conclusion will be reached, and likely the Alumni Association staff will send you a notice with all of the necessary information.

We received a long newsy letter from **Francis Weiskittel** that we plan to summarize in our next issue of class notes. Also, we have a nice letter from **Robert MacMullin** complimentary of our efforts to develop a 70-year mini-reunion. Robert is blind but very much alive. I have been in contact with **Don Way**, **George Michelson**, and **Doc Flynn** and we all send you our best wishes.—**W.O. Langille**, Secretary, P.O. Box 144, Gladstone, NJ 07934, (201) 234-0690

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A note to class agent **Perk Bugbee** from **Benjamin C. Morse** says, "Still hanging in there. Now

I have 13 grandchildren and 19 great-grandchildren, with another due in June." How's that for a record!

George Anderson of Kingville, Md., died in October 1987. Word was received from his daughter.

Here's wishing you a healthy and pleasant New Year.—**Harold Bugbee**, Secretary, 313 Country Club Heights, Woburn, MA 01801

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The only news I have this month is of the deaths of three classmates. Our reunion chairman for the past three reunions, **Donald G. Morse** of Wellesley Hills, Mass., died on September 25, 1988. Don ran a fine reunion. The arrangements were always superb and the entertainment, cocktail parties, and meals left lasting memories. We shall miss him. His wife died some years ago of Alzheimer's disease.

The other two deaths were **Marshall J. Root**, Jr. of Geneva, N.Y., on March 28, 1988, and Capt. **Elliott B. Roberts** of McLean, Va., on July 15, 1988. Elliott was one of my regular correspondents, and I could count on one or two letters a year from him.—**Sumner Hayward**, Secretary, Wellspring House E64, Wash. Ave. Ext., Albany, NY 12203; **Samuel E. Lunden**, Assistant Secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

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In the last issue of the *Review*, it was noted that **Mary and Oscar Horovitz** had left Newton for Florida. Oscar now says, "We are settled in a fine retirement home, a wonderful place for a lazy couple. Extend my invitation to any of our classmates who get down this way to contact me." His address is Fountain View, 101 Executive Center Drive, 3-112, West Palm Beach, FL 33401.

Philip Merriam Alden, retired in Lititz, Pa., continues busy in his community. He is vice-chairman in the Lancaster County Office of Aging Advisory Council and is active in United Way VITA and STAP.

Francis L. Tobin died late in June 1988. A letter to the Alumni Fund from Tobin's cousin, John J. Brown of Somerville, Mass., which included a contribution in Tobin's memory, says, "He lived in Washington, D.C., during the last part of his active business career and for many years after retirement. He lived with his son in California for the past 10 years. He is survived by his sons, five grandchildren, and three brothers." . . . **Leland E. Thomas**, Course III, died May 17, 1988, at age 88. I have no further information about his family or his career. He had been retired for many years, living in Belmont, Mass.—**Yardley Chittick**, Secretary, Rte. 1, Box 390, Ossipee, NH 03864

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The 65th reunion is now past history. It was a successful affair and fairly well attended. Our

class president, **Royal Sterling**, and his assistant, **Horatio Bond**, should be congratulated. Our class, recognized for more than \$60 million in accumulated giving since graduation, set gift records for our 25th, 50th, and now our 65th reunions. We were given a standing ovation when this year's class gift of over \$23 million was announced. Our class estate secretary and chairman of the 65th reunion gift really did a great job!

We were honored at our class dinner by the presence of Institute President Paul Gray, '54, and his wife; former President Julius Stratton and his wife; and class widows Conchita Pearson, Mrs. Skinner, and Mrs. Davenport. A list of all present at the reunion was published in our October 1988 column.

Frederick E. Klutney died March 12, 1988. He graduated in mechanical engineering and was a member of Delta Upsilon fraternity, the Mechanical Engineering Society, and the Aeronautical Engineering Society. During 41 years of employment in Du Pont's engineering department, he was assigned to design for foreign countries as well as for the Atomic Energy Commission. He took part in many outside activities and was recently presented the Keystone Award for significant contribution and long service. . . . **Rosalie Margaret Karapetoff-Cobb** died July 29, 1987. She graduated with an S.M. in chemistry. She worked in the paper-making industry and was the first woman to receive in 1968 the Technical Association of the Pulp and Paper Industry (TAPPI) Coating and Graphic Arts Division Award. She was also the only woman within a group of nine TAPPI members named a fellow.

William Lyman Stewart, Jr., died November 20, 1978. After he received his S.B. in business and engineering administration at MIT, he became senior vice-president of a major oil company, served in World War I, and in World War II was a lieutenant commander in the Coast Guard Reserve. Yachting was one of his many hobbies. He had a very impressive list of accomplishments and activities, including being a trustee of the California Institute of Technology and a member of the MIT Corporation.

Professor Emeritus Gerald A. Fitzgerald died last July 3 in Sharon, Conn. He had an outstanding record in food-processing development, particularly in frozen food. Born in Lynn, Mass., he was educated at Tufts College and MIT. Following graduation, he worked for the Bureau of Fisheries and Wildlife. Later he collaborated with Clarence Birdseye and General Foods. In 1946, he was commended by the Secretary of War for developing canned chicken rations for the U.S. Medical Corps. In 1958, he joined the faculty of the University of Massachusetts as professor of food processing. While there for three decades, he was named to the corporate boards of several firms, including the Borden Co. and Pepperidge Farm, Inc. The American Society of Agriculture Engineers awarded him a blue ribbon for research and development on the distribution of food in the United States. He leaves his wife, Regina M. (Ford), and three sons. —**Frederick O.A. Almquist**, Secretary, 63 Wells Farm Dr., Wethersfield, CT 06109

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65th Reunion

These notes are limited, as **Russ Ambach** has finally completed his relocation to South Bay Manor in South Kingstown, R.I. During the redevelopment of his retirement home in Boston, all 50 men have been evacuated for two years. Russ decided to return to his native state, in the vicinity of Woonsocket where he is remembered as having been the all-time track and field champion in high school. His new home will be near the University of Rhode Island in Kingston.

It is possible that the class news has been lost during moves, but **Don Moore**, class president, is now visiting his niece in Newton from California. . . . **Don Fife**, 65th reunion chairman (617) 255-2072 on Cape Cod, has issued his first call to

arms and will be sending details for June 7 to 10 in Boston this year.

We have a note from someone in Carefree, Ariz., but darned if we can read the name, even after research. Many thanks to the sender. Also, a forwarded envelope from John Harrison '31, with a clipping on the death of **Purinton Fay Marrs**, his brother-in-law on July 17, 1988 in Glens Falls, N.Y. Duke earned his S.B. in Course XV. He was in the student army training corps and was commissioned in the coast artillery in 1924. He joined Dennison Mfg., Framingham, Mass., and later went with Union Bag and Paper Corp., working through the ranks to resident manager and retired in 1961. He sang in the glee club and was a member of the Glenn Falls Country Club, Rotary Club and American Management Association.

The Alumni Register application blank was returned with a note indicating that **Minnie B. Chapman** died December 23, 1985. Our records show her signing for the chemistry course, but we have no word on her career. —**Russel W. Ambach**, Secretary, South Bay Manor, 1959 Kingstown Rd., South Kingstown, RI 02879, (617) 782-4004; **Rockwell Hereford**, Co-secretary, Hacienda Carmel #90, Box 5397, Carmel, CA 93921, (408) 525-7590

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It is with sadness that the passing of **Morrough P. (Mique) O'Brien** must be reported. Mique died on July 28, 1988 in Cuernavaca, Mexico, where he had resided for a number of years. Mique joined the University of California-Berkeley mechanical engineering faculty in 1928 and retired in 1959. From 1943 to 1959 he served as dean of the College of Engineering. Under Mique's leadership, a doctoral program in engineering was established as well as the departments of nuclear engineering, naval architecture and industrial engineering, along with programs in metallurgy and ceramics.

As a researcher, he was a founder of modern coastal engineering. He made many contributions to studies of wave action, beach erosion and other shoreline phenomena critical to planning for use and preservation of beaches. He served as a consultant to General Electric from 1949 until his death and wrote a landmark paper on air compressors that was used in the development of the GE jet engine.

Mique was the recipient of three honorary doctorate degrees. In 1958 he was appointed to the National Science Foundation Board. The Army twice awarded him the Declaration for Distinguished Civilian Service, and he was elected to the National Academy of Engineering in 1969. Among his many other honors were the Lamme Award for excellence in teaching from the American Society of Engineering Education and honorary membership in the Japan Society of Civil Engineering. —**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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In November 1987 **James R. Killian, Jr.** received his last public award before he passed on in January. It was a special award bestowed by the Dana Foundation for his "Work as an educator on behalf of science and technology in the service of society." . . . At my request, Col. **David Bruce Powers** wrote of his experiences lately. While he was in London on business he met an old friend who was with the Radio Liberty-Radio Free Europe. His friend suggested a "leisurely three-week trip to Munich, where he is stationed, via Belgium, central Germany, Bavaria, the Austrian Tyrol and Salzburg. "I say leisurely, but that refers only to the places we stopped. He is a confident German Autobahn driver—80 to 120 miles per hour (I hope it was kph). A bit of strain on my older nerves at times. At present Doris and I are escap-

ing the intense heat in the Phoenix area at our cabin in the southern Colorado Rockies, near the little ranching community of Mancos. Not much excitement here other than a neighbor's losing four sheep to mountain lions a couple of days ago. We are in a beautiful location, on a ridge overlooking a little lake with the 13,000-ft. La Plata mountains just beyond Mesa Verde National Park, and farther to the west the Blue Mountains in Utah about 100 miles away. Here on our ridge, we watch the deer wander through our place, and we do have a number of guests stop by during the summer, before the snow starts to fall and we ourselves have to get out or get snowed in.

Manfred Rauscher of Weesen, Switzerland, died January 15, 1988. He stayed in this country getting advance degrees at MIT, was an early degree holder in aeronautical engineering. He left Cambridge in March 1950 to go back to Switzerland. He leaves his wife, Constance. . . . **James Prince Warner** of Baton Rouge, La., died May 5, 1988. He was vice-president of refining for Exxon. After retiring he traveled around the world, sometimes by freighter. . . . **Curtis R. Washburn** of Cuyahoga Falls, Ohio, died June 10, 1988, leaving his wife, Enid. He was manager of process development, Goodyear Tire and Rubber Co. . . . **Irvine L. Lind** of Oak Harbor, Wash., died January 1987. He was with the U.S. Atomic Energy Commission, Oak Ridge, Tenn. . . . **Robert W. Sherwood** of San Juan, P.R., died April 9, 1988. He has been engineering superintendent of Gulf States Utilities in Texas. His son, Forest, said it bothered his father not to be able to get to Tech in later years, but he attended the reunions up to our 55th. —**Donald S. Cunningham**, Secretary, 27 Lowell St., Braintree, MA 02184

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John B. Drisko drove from his home in Easton, Pa., to his family home in Addison, Me., for several weeks this summer stopping with relatives and friends along the way. John stopped at Epping with me, enjoyed reminiscing about our younger days—ROTC Camp at Fort Humphreys, Va., was a hot six weeks. John recalled his long railroad trip across Siberia in 1929. His career culminated as chief project engineer in the design and construction of the huge Tarbela Dam in Pakistan while with the hydraulics engineering firm of Tippets-Abbott-McCarthy-Stratton (TAMS), New York City. John is our new class estate secretary, and we can expect to hear from him via our alumni office.

Manfred Rauscher, who received his S.B. and S.M. in 1927 and his Sc.D. in 1936, died on January 15, 1988, in his native Switzerland. He became one of the early teachers of aeronautical engineering at MIT for more than 20 years. See more about him under Course XVI news.

Albert S. Walton died on May 27, 1988, in Newark, De. He was, undoubtedly, the senior member of our class, reaching the age of 90 on March 20, 1988. We have no news of his life work. —**Joseph C. Burley**, Secretary, RFD 1, Epping, NH 03042; **Lawrence B. Grew**, Assistant Secretary, 21 Yowago Ave., Branford, CT 06405

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Ernie Knight reports some good post-reunion activities. He and Louise were guests at a Sunday afternoon picnic for family and friends at the home of Mary Nichols' son, Latham, in Barrington, N.H. **Frank Taylor** was there also and Mary, herself. The Nichols family has a miniature but very real live-steam locomotive and train with which to entertain guests plus an interesting collection of antique vehicles. Ernie took along his own high-wheel bicycle to ride there, then returned home with two of them (one to be restored for the Nichols). He and Louise also enjoyed a day's sail in Casco Bay, Maine, aboard

Donald MacMillan's arctic exploration schooner, *Bowdoin*, in June. Ernie has been invited to ride his high wheeler in the Fryeburg, Maine Fair parade this year (1988) and hopes to visit **Roger Haven**, who lives in that town. Please remember that Ernie is now a full member of the '28 class notes team, so you can get your news to this column through him as well as through existing channels. Let's keep him busy!

A note from **Ted Hartshorne** tells us that, although he was unable to attend the 60th, he did improve the time by having two cataracts removed and new lenses inserted. His sight is fine now and has won him a new six-year driving license. His goal now is to outlast the license. . .

Jim Rae missed the reunion because of a conflicting family wedding. He now reports that "the pair was successfully hitched" and already his mind is set on attending the 65th! . . . **Julia and Paul Martini** also missed the 60th but, following that event, they had dinner with Marian and **Jim McCarthy**, who gave them a good first-hand report.

A nice letter comes to us from **Nap LaCroix** in spite of his continuing health problems. Nap suffered a surprise aneurysm in 1987 and recovery has been slow. Then adding to existing troubles, his car caught fire and burned right in front of his house. However, Nap is looking ahead and would like some recommendations for bed and breakfast type lodgings in the Caribbean (for two or three months). Please send in your suggestions or, better still, write directly to Nap. . . . **Dick Hildick** says that he and Anne have had less than their usual level of activity and travel in the past year but have enjoyed interests closer to home. They were immensely pleased to have letters from **Harlan Paige** and **Walter Norton** both of whom supplied details of the reunion. Dick, who earned and received the 60th memorabilia items had this to say: "The mug seems bigger than some we have had in the past. Does this imply that we are now bigger beer drinkers than we used to be?"

We heard from **Mary and Max Parshall** twice, once by mail and then by telephone. They had a very hot summer in Hamilton, Mont., and forest fires were all about them. Luckily, their home proved to be in a safe place. Max is holding his own healthwise and they still entertain friends at a nearby favorite dining spot "just up the mountain." Says Mary: "Eighteen switchbacks from there you can see the whole world!" Mary stays well and continues to teach piano as she has done since 1950. They are blessed with very helpful neighbors. The Parshalls are very special to M.I.T. and '28. . . . **Henry Buntschuh**'s older son, Charles (M.I.T. '53), and family spent their past summer vacation touring Germany and Austria. Henry and Virginia joined them in Austria and had a happy time visiting in his old home town, Krems, and in Vienna. Henry tells us that Krems was established by a Bavarian bishop prior to the year 1000 as a bulwark against the invading barbaric Huns from the East. Henry's younger son, Robert, is also an M.I.T. grad (class of '55).

We have one final but sad note: Clara, widow of our classmate **Arnold "Arch" Archibald**, died June 18 1987. An alumna of Radcliffe, Clara was early on a designer-actress in professional theater, then an instructor in drama and fine arts at Rollins College. She and Arch traveled together abroad photographing solar eclipses. Arch died in June 1980. Our thanks to **Frannie Donovan** for this report on Clara.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890; **Ernest H. Knight**, Assistant Secretary, Raymond, ME 04071

"My wife Doris (married 46 years) passed away on October 9, 1987 in Florida. Since then my whole world has changed (for the worse)." Joe and his wife were very active in class and MIT affairs until they moved to Florida some 12 years ago. He joined the newly organized MIT Club of Fort Lauderdale where he attends the meetings regularly. His hobbies are golf, swimming and attending lectures.

Edward B. Papenfus of Vancouver, BC, Canada, writes, "We continue to live quietly in retirement and welcome all news of old MIT friends and ATO fraternity brothers." His hobbies include gardening and financial planning for his family and friends.

James C. Reddig of Webster, N.Y., writes, "My 81st birthday was wholly uneventful. But, summertime roused me to join the annual trek to Oshkosh, the world's biggest airshow. With a B-1 bomber on exhibit and a *Concord* flying enthusiasts once around the pea patch, even the record heat failed to spoil the enthusiasm. My daughter, Mrs. Jan Coggshall, was re-elected for her third term as mayor of Galveston, Texas. This has turned into an interesting career for a Wellesley math major." We wonder how she coped with the recent Gilbert (hurricane) and how much damage her city sustained!

George A. Crandall of Casper, Wyo., has sent me a note as follows. "I am now 82 years old and I feel great. I have been working part time selling sporting goods for Fanning Wholesalers for the past four years. I sent the enclosed letter to all my 160 plus dealers on July 1, 1988. I have decided to retire for the fourth time. The first time was when I reached 60 in 1966, after 33 years in the U.S. Army Reserve. I thank you for all the business you have given me in the past, and the thing I value most is your friendship, which money does not buy. I will miss you, but it is time to go fishing. . . . Retirement with nothing to do isn't for me. I have to have something that needs to be done everyday. Maybe I should take up golf, but I tell my golfing friends I am not old enough yet, as golf is an old man's game." George attended our 45th reunion with his wife, Willa. They have five children, eleven grandchildren and four great grandchildren. His hobbies include fishing, and coin and gun collecting.

Richard Piez of San Mateo, Calif., writes, "Your birthday greetings came today, and with many twinges of conscience, I offer sincerest thanks. My retirement facility is scheduled to be ready about November first, but I have requested a December first move-in date. At this moment, I am in the midst of selling our house, an activity of no great pleasure. I must dispose of some of our furniture in anticipation of moving from a good sized, comfortable house into a 800 sq. ft. apartment. Will send you my new address as soon as possible."

Your reunion committee had a meeting at the MIT Faculty Club, where the final program of activities and events were discussed and approved. The number of positive responses to our first mailing was very encouraging and you will soon receive details of our 60th reunion events. Let us make an effort to attend what may be our last major reunion. Those who attended the meeting were: Helen and **Karnig Dinjian**, secretary; Ellie and **Vincent "Jerry" Gardner**, general chairman of the 60th reunion; Ethel and **David Wilson**, treasurer; and Dorothy and **Herman "Frits" Meisner**. Also, two representatives of the MIT Alumni Office were there to assist us.—**Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

ion chairman. The first draft of a reunion letter is being circulated for comment and then will be mailed to classmates. Further details will be given in the class notes from time to time.

The rest of the material at hand this month is, I'm afraid, pretty much all downbeat. It comprises notices that six more of our classmates have passed away. The remotest report comes from **Kittiporn Limpisvasti** who writes from Bangkok that "his Dad" **Perm Limpisvasti** died on January 12, 1988. Known as "Limp" during his student days, Perm was managing director of Thai Airways prior to his retirement and had the title Air Marshall. He is survived by his wife, six children including **Kittiporn**, who is the fifth son, and 12 grandchildren. . . . A brief note from the administrator of the City College of New York School of Architecture brought the news that Professor **Joseph Shelly** died some years ago, no specific date being given. My records indicate that Joe taught the history of architecture, first at Columbia University and then at City College. He was at one time on the New York City Landmarks Preservation Commission. Apparently he never married.

A note from **Ann Fahnstock** Cody brings the sad news that her father **Frank Fahnstock** passed away on May 26, 1988, near his daughter's home in Zephyr Hills, Fla., after his second serious stroke. Those of you with long memories may recall that although severely handicapped by his first stroke in 1970, he managed to make it to the 45th reunion at Chatham Bars. Frank worked for Socony-Mobil for 39 years as an engineering consultant. Among other things he supervised the design and start-up of Mobil's first catalytic cracking patents. He and his wife Kitty, who predeceased him, lived for many years in Roslyn Harbor, N.Y., where he was active in civic affairs, and spent their summers in Madison, N.H. In addition to daughter Ann, Frank is survived by a son John of Hialeah, Fla.

George Holt died on May 14, 1988. For most of his career he taught art and architecture at Bennington College and lived just across the N.Y. state line in Walloomsac. As a sideline he owned and operated the Walloomsac Christmas Tree Farm. After his retirement from teaching in 1968 he concentrated on his color photography hobby and his photographs were frequently included in exhibits in the Bennington area. He is survived by his wife Jean and two daughters, Sarah Schwarts of N. Bennington, Vt., and Charlotte Menasuta of Rome, Italy. . . . **Leon Thorsen** was born in Ellsworth, Maine, lived in or near Ellsworth nearly all his life and died there on May 23, 1988. He owned and operated various manufacturing enterprises in Hancock, Maine, notably the L.S. Thorsen Corp., a frozen blueberry processing and ice-making business at Thorsen Farm. He was a selectman of the town of Hancock for about 10 years. His wife Calista, to whom he was married for 56 years, predeceased him. . . . **Wallace Hope**, who died on June 24, 1988, was one of a rather small group of classmates who elected Course XIV and initially had a bit of a problem finding a job in his chosen field of electro-chemistry. During the 1930s he bounced around with a record 11 jobs in nine years, but then settled down in Port Huron, Mich., with American Autolite for several years. In 1945 he moved to the Standard Varnish Works in Staten Island, N.Y., that became a subsidiary of Montgomery Ward, where he worked for 26 years.

During this period he developed their Wire Coatings Division and as chief chemist supervised the development of many new products, of which a few were transported to and left on the moon. In 1974, after a heart attack that "persuaded him to let up a bit" the Hopes moved to Boone, Iowa, to be near their children and where they were living at the time of his death. According to my records Wally is survived by his wife Nina, three children and seven grandchildren.—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 06488

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60th Reunion

Arthur E. Turner of Tucson, Ariz., has sent a brief note stating that both he and his wife Gretl had a stroke about a year ago. She did not survive, but he was luckier. He got over it and is presently ambulatory.

Joseph Green of Coconut Creek, Fla., writes,

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Last September we took our first definitive step toward a 60th reunion. At the urging of president **Ted Riehl** of Tucson, Ariz., **Yicka Herbert**, **Reg Tarr** and I met with Eliza Dame of the Alumni Association staff for a preliminary planning session. Yicka has agreed to assume the job of reunion

The Alumni Association sent a large stack of information received from classmates. I'll be reporting on these during the next few issues of class notes. **George F. Cohen** writes that he retired in 1971 due to ill health. At that time he moved to Florida where he lives in a retirement community. He is active in numerous charitable religious and civic organizations and his favorite sports are shuffleboard and swimming. He has two children, a son and daughter (his son and son-in-law both attended MIT); and seven grandchildren. . . .

John Holcombe Dodge teaches the advanced placement course in physics at two local high schools on a volunteer basis. He is also engaged in preparing the 7th edition of a physics textbook of which he is a co-author; and he instructs in workshops for science teachers in senior and junior high schools. His chief recreations are bike riding and mountain hiking and "also trying to keep my fingers supple enough for the piano."

Norman D. Fitzgerald notes that his courses of study at MIT, mining engineering and petroleum engineering, no longer exist in the alumni register but are now included in materials science. He says, "I always get the feeling that I am an academic orphan, for as far as I can determine no current publication indicates that anyone could have obtained a degree in either of these highly significant fields." . . . **Horace Sayford Ford** tells us his principal hobbies are sailing, both cruising and ocean racing; and skiing previous to his move to North Carolina and then Florida in 1968.

. . . **Frank E. Garratt** spent only one semester with our class after which he had to leave, having contracted tuberculosis. He resumed his education three years later at Carnegie Institute of Technology and from there spent 40 years in the steel industry, retiring as plant manager in 1974. He has lived in Pittsburgh since retirement.

William D. Harrison tells us how he came to Tech and left and became a pilot. "All through my earlier youth, I had been fascinated by machines, all machines. I built working models of boats, airplanes, radio sets, etc., and did photo printing and developing. It would seem that I was an ideal candidate for Tech, but as I discovered later, I was not ready for that great step. I had not learned to study! . . . After struggling along until early 1929, I finally received my coup-de-grace from Dr. Merrill, who pointed out the futility of my position, and excommunicated me. In October 1929 I went to Texas, and became a pilot in the U.S. Army Air Corps. If that had not happened to me, I never would have experienced the incomparable exhilaration of flying alone, high in the valleys and caves of a summer cumulo-nimbus at sunset!" . . . **Francis J. Hermann** has retired from RCA, where he published a few papers. "My wife has so many volunteer community activities I can not keep track of them. Since, in retirement, I started teaching at Drexel, I find little time for off-campus activities; I serve as secretary to the electrical and computer engineering department faculty." His lifelong hobby has been photography and while he used to be a radio ham he is now a computer "buff" which he says ties in with his teaching at Drexel University. His older son received a Ph.D. in history and is now executive director of New Jersey's Election Law Enforcement Commission. His younger son, a lawyer, is deputy chief counsel to the Governor of New Jersey.—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mt. Dora, FL 32757; **John Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158

Several of our classmates sent out New Year's greetings and sometimes included a general letter and pictures. Rose and **Tom Weston's** letter had anecdotes about their children and grandchildren and comments on their trips and activities. Some highlights:

"Tom strayed a bit into Massachusetts politics by obtaining signatures on two referenda petitions—proposition 2 1/2, most successful (850,000 "yea") and the repeal of the "emergency" pay raise (100,000 signers) to appear on the ballot in 1988. Tech received \$1,363 million in U.S. government contracts in fiscal year 1986. Tom caught the bug a year ago when he ran a successful campaign for our good friend Robert Howes, who was elected to the post of town treasurer and collector, winning by 38 votes. Outside of politics, Tom is quite reasonable."

"We took off for nine days. After a night in Scranton, Pa., we drove to Virginia, spending two nights in Waynesboro and Charlottesville. We visited Monticello, Michie Tavern, and James Monroe's home, "Ash Lawn." We were so impressed with all the special effects Jefferson built into Monticello. Next was a night at Natural Bridge and on into West Virginia. We have never traveled such winding, but scenic roads."

Katherin Burrows writes that she and Sam live rather quietly in Englewood, Fla. They attend the Southwest Florida MIT Club meetings. She chatted with **Bob Follansbee**, who lives a few miles away in Venice Isles. Katherine works with her flowers, and Sam does a little pottery. They are involved with church work, Meals on Wheels, Audubon activities, grandchildren, and visitors. . . . **Henry Jacob Chapin** is still active as a consultant. His primary outside interest is church activities. He is a co-author of six technical articles and, as co-inventor, holds six patents. He is a contributor to *Metals Handbook* and is on the planning committee for their next issue.

Frank Richardson Cook has completed demographic research yielding very valuable evidence that will help third-world countries with population growth-rate problems. Frank, your classmates would like to hear more about your thoughts on this subject.

Willem Holst writes that his special interests include travel and photography. He frequently gives talks and slide shows on his experiences in Japan, India, Greece, France, Italy, Spain, North Europe, and Leningrad. He pays lasting tribute to his late wife, Margaret, a Wellesley art major, for helping him focus on major art experiences. His new bride-to-be, Mary Davis Pettersen, a Fulbright Scholar in mathematics, shares his interest in classical music, ballet, and opera. They plan to sail along the Danube River to Vienna, starting from Istanbul. . . . **John Lawrence** sends us a short note. He is still working ten hours a day.

As for myself, I want to mention that I still play a lot of tennis (singles and doubles). My game probably peaked two or three years ago, but my golf game is still improving. Recently in an important tournament at our club, my team came in third, and the four of us each received VCRs. I personally won my first golf trophy for the best score in my handicap division.—**Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

An interesting letter comes from **Walt Skees**, Apartado 627, Barcelona, 08080, Spain. Walt owns "extensive beach land, Green Turtle Cay near Treasure Cay resort, Bahamas." This is offered to alumni interested in a camping trip with nearby village shopping facilities. He also would be charmed to sell any one of us one or more lots. . . . **John Longley**, 1623 New Scotland Rd., Slingerlands, NY 12159, wrote Charalee and Dick Fossett a long report on his and his family's ham operations—over 40 years, still at W2ANB, and remarkably his wife Lil operates W2ZPR. She is an artist as are one of their sons and daughters-in-law.

William Wilson "Ike" Newton has provided the Alumni Association with the following. (These replies will be quoted in this column serially as there is insufficient room to handle all at once.) Ike had a geophysical part in the discovery

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Ten Post Office Square
Boston, MA 02109
(617) 542-2290

Of Counsel
Alfred R. Johnson, '35
Joseph Zallen, '39

of many oil fields in the west and southwest of the U.S. and in Australia as well as constructive research technique developments. He resides at 4703 Wildwood, Dallas, TX 75209. . . . **John D. Sweeney**, M2 Woodland Trace, Tuscaloosa, AL 35405, studied in Course 4. His thesis earned the highest grade. John became a member in the College of Fellows, president of his AIA Chapter, and chairman of State Registration Board. He was an officer in the U.S. Army Corps of Engineers in World War II, followed by a general practice, retiring in 1979. . . . **Robert W. Timbie** of 1129 E. Dunmier, Pensacola, FL 32504, golfs three times weekly with fellow retirees. He has ten grandchildren, three married, two in college. Daughter Judy wins painting awards, son Sid owns a company with about 1,000 employees, son David is in Arlington County government.

I sadly report the demise of **John J. Hanlon**, 1553 Calle Candela, La Jolla, CA 92037. Mrs. Hanlon at that address.—**William B. Klee**, Secretary, Box 7725, Hilton Head, SC 29938

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55th Reunion

Our 54th mini-reunion in September at the Basin Harbor Club in Vermont was a thriving success. There were 39 class members on hand and we were the beneficiaries of generally good weather. The Club was all that **Cass Belden** had promised and I'm afraid that, despite sporadic efforts at walking off their good food, a lot of us came home on the heavier side. They have a grass landing strip so that Jean and **Dick Sanders** could fly in and a good course for the golfers. Most of the non-golfers spent one of the days visiting the Shelburne Museum, about 20 miles away. This is a fine exhibition of "Americana"; some of the buildings are old ones that have been relocated to the site and some have been newly built. There are not the "active" exhibits that you find at Sturbridge, Mystic Seaport, and Williamsburg but those of us who went found a whole day none too much. On one of the evenings we were treated to **Paul Wing's** latest 3-D effort, a show that was built around stereoscopic slides that were over 100 years old.

In the October *Review* notes **George Bull** included some information from **Frank Moore** about a 50th anniversary party and also some rail fan trips to South America. Frank has also written me about a 1988 trip he made to Ecuador and Columbia. In the latter country he had the pleasure of seeing locomotives still in service that were based on designs he had done years before at Baldwin Locomotive Works. In particular, he saw one class of 3-foot gauge engines with 72" boilers that were the first ones he had designed. In recent years he has also made rail fan trips to India, East Africa, and South Africa. Frank says he hasn't turned his back on active association with railroad work—he is still working on catenaries for Amtrak's 125 mph railroad.

Something new seems to have been added to the material sent me from the Alumni Office: copies of requests for career activities, feelings about MIT, etc. I don't seem to recall this myself, but I have a number of them, some from classmates who have been mentioned before and others who seem new names. None of the material seems particularly "time sensitive" so I will work them in as space permits. Some are short, some are lengthy; so if your name shows up and the words appear a little different, blame the paraphrasing on me.

Henry N. Andrews: "I believe that in a previous report of this nature I have listed various fellowships-Guggenheim, Fulbright, and National Science Foundation; research oriented travel in Europe, India, and East Africa; and teaching at Aarhus University, Denmark. My overall feelings about MIT—a bit too strenuous at times-no 'culture' but in any event I have profited greatly from the educational experience I had at Tech. I majored in food technology but drifted into plant science and paleontology. I've lived an interest-

ing, and I hope, significant life and I'm grateful to MIT for my start."

Roger B. White: "I did not develop positive feelings about my career and work activities until a couple of years after starting with Union Carbide, I realized that my training at UC and my education at MIT had given me specialized knowledge that was valuable to customers and that generated genuine respect toward me. This solidified my resolve to start a business of my own, where there would be no question, in my mind or others, who did it. Actively occupied in promotion of the oriental board game called 'GO' since retirement, i.e. during the 1980s, as a volunteer organizer in the American GO association."

Melvin A. Sousa's interests are: horses, breeding, training, and showing in dressage and eventing, and citrus farming. It's interesting that in this instance Melvin made no mention of his career in the aerospace industry that he described for our 50th reunion booklet.

As you can see, this sampling of comments covers quite a range of reactions. As they say in the soaps, "Listen tomorrow for more of the lives of the Class of 1934."

By the time you read this, the first announcement of our 55th reunion will be in your hands. We hope it will prompt you to a positive interest; 1934 reunions have always been notable for their attendance and the increasing turn-out for our mini-reunions shows that we enjoy getting together. So plan on this coming June.—**Robert M. Franklin**, Secretary, P.O. Box 1147, Brewster, MA 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20815

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Our Boston area mini-reunion was a great success on September 29th at the Wayside Inn with the following in attendance: Anna and John Alden, Marilyn and Leo Beckwith, Joyce and Arthur Cohen, Sarah and Phoenix Dangel, Janice and Leo Dee, Nathlie and Thonet Dauphine, Rose and Ellis Flink, Sylvia and John Hossfeld, Richard Jarrell and Mervery Foster, Alfred Johnson, Allan Mowatt, Rhoda and Bernard Nelson, Chris Rafferty, Warren Seamans, Barrie and Dick Shaw and Deborah Shaw Macchi, Walter Stockmayer, Virginia and John Taplin, and Jerri and Bernard Whitman. The ballroom at the Wayside Inn was buzzing with happy conversation from noon on and we all enjoyed the good Yankee food which only served to give us a chance to catch our breath. God willing we shall all be at the 55th in June 1990.

With the help of the Alumni Association I am receiving sheets which you have filled out for them listing hobbies, special interests, volunteer activities and more about yourself and family. What a bonanza! I have 25 of them to start with and presume more will be coming. So I shall start with words from those we have not heard from for a while with their current home city and state. **Karl Achterkirchen**, N. Hollywood, Calif., retired in 1977 and celebrated his 50th wedding anniversary the same year. He says he is quite active and you will have to agree; he plays tennis and racquet ball, gardens, travels, is docent at the California Museum of Science and Industry, and delivers blood for the Red Cross. . . . **John P. Brosnahan**, Venice, Fla., serves as a volunteer on the Dewey Fire Co. Ambulance Squad and Good Shepherd Home and Rehabilitation Hospital Emergency Room. . . . **Edward J. Collins**, S. Easton, Mass., says his greatest accomplishments occurred during World War II serving as Administrator of the L-41 Stop Order on Construction in 1942 for the War Production Board, then as production coordinator of tank track production in 1943 (army ordnance); and chief of the internal combustion engine branch of the War Production Board in 1944. . . . **George C. Dunlap**, La Feria, Texas, has hobbies which include hiking, amateur radio and trout fishing. His

volunteer activities include scouting, president of Rio Grande Council for two years, the La Feria Utilities Board; Kiwanis Club, president and other offices; and volunteer examiner, FCC, amateur radio. . . . **Jefferson Farmer**, Mountain Home, Ark., writes that he spent his World War II service from August 1941 in ordnance plant construction for two years and then pipeline construction in India for two years. His hobbies include shop work using wood, plastic, aluminum and steel; and boating and fishing.

I am sorry to report to you the death of **Theodore "Ted" Pomeroy** in Cooperstown, N.Y., on August 1, 1988. He lost a five-month battle against cancer, his widow Thelma reports. She is planning to stay there where Ted had built such a pleasant 15 years of retirement. I am sending her our deepest sympathies for her and her family.—**Allan Q. Mowatt**, Secretary, P.O. Box 524, Waltham, MA 02254

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A footnote on last issue's notes: while in Knoxville with **Charlie Hobson** and **Bob Hunt**, we tried to call **Dick Hickman** (Course XVII) and after lunch drove past his home. It was obvious that he was away, and Dick had some lawn-mowing waiting for him on return. My travelogue continues north to the District of Columbia and **Dave Varner** who is still fully active in the law firm of Cushman & Darby. Dave was delayed getting home to Bethesda so wife Mary Frances filled me in on their interest in the National Cathedral, and how its completion was financed and the necessary debt retired expeditiously. The year before last, she and Dave celebrated the 50th anniversary of their 1937 wedding, when **Mal Holcombe** was best man.

Bob Walker was a Depression victim and had to leave the Institute during sophomore year, but later continued at Boston University and Georgetown for a business administration degree and master's in foreign service. His career as an international economist in the Department of Commerce took him to Europe several times, and Belgium awarded him the Honorary Order of Leopold. At our 50th reunion he recognized **Mac Nyhen** as an old colleague in Commerce, and **Phil Gilinson** as an acquaintance at the church which he and wife Thelma attend. Bob's sister Irene worked for the Alumni Association for 40 years and compiled the register of former students. I learned from Bob that **Henry McGrath** was only a few miles away at 1092 Fairbanks St., Great Falls, VA 22066, so I scooted over. This home replaced one nearby that burned to the ground in 1985, consuming the original papers on Henry's numerous patents. One of these was a chemical process which revolutionized synthetic ammonia production worldwide. Others concerned synthetic fuel production, and during his term of office President Carter was an avid reader of Henry's weekly report on synthetic developments. Henry is in great shape, and recalled his many trips in Tony Dauphine's ('35) car to ski the White Mountains.

On to New Jersey: **Ray Woodrow**, who joined us as a graduate student in Course VI-A from Williams, had just moved that week from Princeton to 626 Windsor Way, Rossmoor, Jamesburg, NJ 08831. He had been under treatment for emphysema, and was too exhausted from the upheaval to see me. I promised Isabelle to try again on another trip. As you will see in the 50th biographies, Ray's career in research and research administration (OSRD, MIT Radiation Lab, NATO, Princeton University faculty) was outstanding, with citations and awards right up to his retirement in 1978. We wish him well for the future. . . . **Milner Wallace** and Robin greeted me warmly and served lunch amid stacks of cartons as they prepared to move to 11 Wallace Brook Rd., RR2, Brookline, NH 03033. They were leaving Saddle River, N.J., after 40 years, and their Saddle River Realty Co. For the last five years Milner was a

volunteer fireman, and, as a result of doing an article for "Friends of MIT Crew Newsletter," found that he liked writing. So he wrote a series of articles on firefighting in the Saddle River weekly paper. They are good and brought a big response from his fellow townspeople. Robin has a unique project also—making thousands of placemats and personalized birthday cards by covering unused calendar scenes with plastic, with the proceeds benefitting community activities designated by the buyers. It is a pleasure to find so many of our classmates with an "up-and-at-'em" spirit.

Even **Charles Kennedy**, in the extended care unit at St. Joseph's Hospital in Elmira, was cheerful and recalled his varsity basketball days with **Fletch Thornton**. Chuck came briefly to our 45th reunion, and was then in the pink of condition. Chuck came to the Institute from Hamilton College and finished at University of Michigan. His career in valve manufacturing and later, until 1983, in utility operation was topped with the jobs of president and CEO. Writing this in late August, I called him at his summer place in Stone Harbor, N.J., and found him up-beat as he rested and enjoyed the scene from a porch overlooking the beach. . . . In Rochester, **Harry Essley** recalled his days as manager of crew, responsible for getting oarsmen, shells and equipment to distant regattas. On one trip to race Yale on the Housatonic, the wooden-wheeled shell carrier threw an iron rim en route. After much searching, Harry found a blacksmith to do repairs, and delivered the shells next day, shortly before race time. Harry retired early from Eastman Kodak to pursue with wife Betsy unusual activities in many parts of the globe, starting with a year on the hospital ship *Hope*. Betsy did audio-visual testing, and Harry was Mr. Fix-It for the hospital's equipment of all kinds.

In the Detroit area, I met with a pleasure and a disappointment. **Henry Johnson** and Dorothy were warm with hospitality, including their well-

stocked guest house and dinner at the club, but **Obie Falls** (Course VI-A) was going out of town at the very time I proposed to see him. Henry recalled the 1936 Thorn-Loomis sponsored tour of European industrial plants, including a Zeppelin under construction at Friedrichshafen. At the last minute the Nazi guides cancelled the visit, but at 7 a.m. the next day, before the guides appeared for travelling to the next stop, a young relative of a Zeppelin official got the students admitted.

What they saw was a wholly new system of rigid-airship construction, unknown to the world! Henry was honored recently by his home town of Niagara Falls for endowing a scholarship at M.I.T. with preference to a local high school graduate. The Mayor declared a Henry Clyde Johnson Day, with appropriate media coverage.

In Ann Arbor, Mich., I had lunch with **Wayne Hazen** and Jean. Wayne went on to get his Ph.D. in physics at University of California. As professor at University of Michigan in particle physics and cosmic rays, he has researched widely (see 50th Biographies). When you read about the "big bang" theory, supernova, neutrinos, etc., Wayne is there. Wife Jean is fluent in Mandarin, and they have been to China many times since 1980, working and for pleasure. Active? Yes! Before this is in print, he will be in Beijing again, reviewing the work of a Michigan Ph.D. candidate. Wayne remembered an undergraduate effort with **Tom Terry** and **Martin Gilman** to snowshoe up Great Gulch at Mount Washington, but the weather turned them back. He also spoke of **Eli Grossman** and **Bernard Vonnegut** as long-time friends. So I later mailed him my copy of Bernie's paper on lightning research (see February-March '87 issue of Class Notes).

Our last visit to a classmate on this trip was with **Pete Weinert** and wife Jean at Barrington, Ill. Phoebe Phillips drooled as Pete related some of his sailing adventures—trans-Atlantic, trans-Mediterranean in an Alden 44, and others. He has kept his eyes sharp looking for the next buoy

on a course, and reads the telephone book without glasses. He was grabbed to chair the race committee shortly after moving to Lake Barrington in 1984. Since retirement from Universal Oil Products as senior vice-president in 1979, he has done some consulting—as PetroPete Inc. They had just returned from a bus trip through Spain and Portugal.

That's the end of our 1988 odyssey, but at several stops along the way we heard of the 50th wedding anniversary party of **Fletch Thornton** and Peg, which she and daughters Ann Bridges of Woodstock and Susan Starbuck of Seattle engineered. Some 133 guests for lunch at King Ridge Ski Lodge (Vermont) included **Gordon Thomas** and **Elwood Koontz**, who were ushers at the wedding, and **Milner Wallace**. **Harry Essley** and Elizabeth could not attend, but sent pictures taken in the 1940s when they were near neighbors.

Other news has been catching up on me while reporting our April-June visits. A *Schenectady Gazette* clipping from **Larry Peterson** to Assistant Secretary **Jim Patterson** tells of **Bernie Vonnegut's** patent for a new instrument to measure wind speeds—perhaps up to the speed of sound. It is called an oscillatory anemometer, "the first real change in the wind vane since the common cup anemometer was invented in the 1850s." It does not blow away in a gale, as the cup type has done on Mount Washington, because it can be more rugged and offer minimal resistance to the gales it measures. Jim remembers Bernie's fast breaststroke in the medley relay, which gave Jim a big lead for his lap and helped set an MIT record, with "straight" T's as rewards to the relay team.

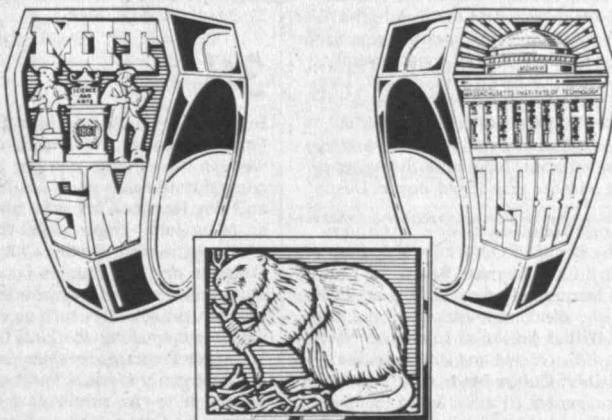
Also via **Jim Patterson** a letter from **Chet Meyer**, a fellow Course IIer, telling of winter sports in Keystone, Colo., and summer activities at Pewaukee Lake just west of Milwaukee. Just in the past year he is into golf. Why not?—wife "Annabelle is a great golfer." His letter conveys a great zest for

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outdoor activity and mentions Art Sarvis and Betty joining them at Keystone a few years ago. . . Augie Mackro had a total knee replacement last February and is not yet up to full strength because "replacement parts are not as good as original equipment." So he is confined to reading and amateur radio via the new amateur satellite, OSCAR 13. But he hopes to walk around Hartland Pond when another mini-reunion is held at Alice's place.

In July Jim Patterson and Marian tripped to Prince Edward Island, Canada, visited **Angy Tremaglio** and Edith at their summer home there, and were treated to one of those famous church suppers of lobster. Angy, Course XVII, spent his career in building engineering and construction, running two companies of his own. Along the way he had the pleasure of son Richard's graduating in the class of '68 in architecture and later becoming professor in Course IV. . . . Charlie Holman and Lucy came to visit in Santa Fe early in September before the skeet competition in Albuquerque, and I learned that Lucy, with only five years exposure to any shooting, had recently scored 100 out of 100 "birds"!

Let's give cheers for the life of **George Ray**, who died May 20, 1988. A letter from his widow Nancy (5105 Macbeth Dr., Anacortes, WA 98221) tells of a long and happy marriage while he pursued his Course XVI bent with Bell Aircraft in Buffalo and Boeing in Seattle. "Larry Bell sent him to Moscow for four months in 1943, and also to observe the Korean War including the front lines. . . . Many interesting trips including the Paris Air Show and Farnborough (England) for Boeing." Retiring from Boeing, he became vice-president of Mundelein (Ill.) Savings and Loan, and then back to Washington where he resumed "contributing to this beautiful area of the Northwest with many volunteer works and interests. . . . George was a credit to his family and community." Thank you, Nancy, for your fine tribute, and best wishes for your future.—**Frank L. Phillips**, Secretary, 901 Los Lovatos, Santa Fe, NM 87501, (505) 988-2745; **James F. Patterson**, Assistant Secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171

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Phil Dreissigacker retired May 1, 1980, as vice-president—Technology of the Farrel Division of Emhart Corp. He is semiretired and is a member of the Finance Committee and Personnel Council of the town of Orange, Conn. He belongs to the Milford Yacht Club and is a member of the race committee. His winter activities are skiing both downhill and cross country, and in the summer gardening, woodworking, and toy making for the annual church fair. In his workshop he organized a group of four to six men (the woodpeckers) who meet weekly for a toy-making project. Last year the October Fair netted \$1,950 in toy sales. Phil writes, "My major travel effort is to visit relatives in North Carolina and our two sons and families in Vermont. Now have three granddaughters and another grandchild due in December."

Thomas Francis Hennessy writes, "I am vice-president of the Board of Governors of Indian Springs Country Club, Boynton Beach, Fla., and also their architectural advisor. Hobbies are PGA golf, Palm Beach, sketching, watercolor, and travel. . . . **Harry Wilbur Janson** of Fairhaven, Mass. writes, "Seven U.S. patents and one Canadian patent. . . . **Gilbert Culver Mott**, who lives in Fairfield, Conn., writes, "I am a board member of the Bridgeport Engineering Institute, Council of Churches of Greater Bridgeport, Greater Bridgeport Symphony, and 3030 Park Retirement Home. I am also a consultant to the National Executive Service Corps." . . . **Duane Oren Wood** reports from Los Angeles that his hobbies are skiing, hi-fi design, and travel. . . . **Raymond B. Ramsey** of Sarasota, Fla., retired as a supervisor from Bell Labs June 1, 1981. Wife Jean's main interest is be-

ing a housewife, and his hobbies are tennis and bridge.

Lewis Philip Reitz writes from Verdes, Calif.: "My hobby is big-band record collecting. I own 1,000 78 RPM records, 5,000 LP's but no compact discs yet! I am a member of IAJRC (International Association of Jazz Record Collectors), which supplies senior citizens with cassettes tapes of the big bands. (No charge, of course—it's legal that way.)" As most of you know "Pete" supplied each of those class members who showed any interest at all in our 50th reunion with a cassette tape of the "Sounds of MIT," which contains a reconstruction of a series of records he made for MIT in 1938 for the alumni association. He presented the master tape of this program to the MIT Archives. He noticed that it was put to good use for the new "MIT Thinking About the Future" video cassette made by MIT.

Dr. Bernard D. Ross, M.D., of Port St., Lucie, Fla., writes, "Engaged in the private practice of internal medicine. Have developed a new non-specific medical therapy and in 1984 published a book entitled *The Fundamental Pathway to Better Health*, Book Publishers, Tampa. Expect to publish a sequel in the near future. . . . **Hugh Taylor Smith** of Escondido, Calif., writes, "I am a member of numerous railroad or transportation museums including one in Warehouse Point and one in East Haven, Conn., and one in Perris and one in Campo, Calif. I have been in the fire-alarm business for 39 years and am well thought of in the industry. My wife and I have taken numerous cruises in Europe, Canada, and Alaska. . . . **Tom Hallenbeck** of Toledo, Ohio, wrote on August 1: "Still alive. My bones are losing calcium too fast. Wife Pet is a gem."

I regret to report the deaths of **Robert Goldsmith** in July in Great Neck, N.Y., and **George B. Wemple** in New York City. Bob worked for Ammann and Whitney for more than 40 years. As a structural engineer he made important contributions to the planning and design of many major bridge projects including the Verrazano-Narrows and Throgs Neck bridges in New York City, the Walt Whitman Bridge in Philadelphia, the General Belgrano Bridge in Argentina, and the recent rehabilitation of the Golden Gate Bridge in San Francisco. He was also involved in the design of the Pittsburgh Arena as well as numerous other bridges and building projects in the U.S. and abroad. He was a fellow of the AMSCE and a member of the main committees of the American Welding Society. A recognized authority on structural welding, he wrote several articles on the subject. He is survived by his wife, Elsa, son Christopher, and daughter Joanne. **George Wemple** died in April and is survived by his wife.—**Lester M. Klashman**, Secretary, 289 Elm St., Apt. 71, Medford, MA 02155

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For 30 years Phyllis and **John Craig** have vacationed at a lodge we drive by several times a week in the summer—yet our paths hadn't crossed until this summer. A few days later Alice and **Roy Hopgood** hosted a mini-reunion of the six of us. John, Hoppy and I had all been in electrical engineering together. John's biographical sketch in our 50th reunion book was a bit modest. He could have included several additional volunteer activities such as chairman of the advisory council for the local Retired Senior Volunteer Program, president and chairman of the Emergency Medical Service for an area embracing 20 towns, president of the Whitney Retirement Center, deputy first selectman, and chairman of the screening committee for the development for elderly housing. Their travels have recently included Australia and New Zealand and, with luck, England and Scotland are in the cards for next spring.

From the Alumni Fund we have information about **Harold McGillivray**, who for years was active in MIT affairs in the Tampa area. After retir-

ing in 1970 from Pittsburgh Testing Laboratory, he founded Waterfront Recovery Contractors, Inc., medium marine contractors rebuilding Gulf-front seawalls damaged by hurricanes, and also small boat marinas. As this is written (September) we wonder when Harold will open offices on the Texas Gulf Coast and Yucatan.

We had expected to report that **Sandy and Lou Bruneau** had captured several golf trophies in the Scottish foursomes. Instead Sandy picked up the wrong kind of trophies: a sling and harness to hasten the mending of a collar bone fractured in a fall right in her own yard. Sorry, Sandy.

To **Corny Roosevelt**, many thanks for his August 28 card reporting that he and Andy Corry, '44 (retired executive of Boston Edison) were sending greetings from "an impromptu unplanned mini-reunion 300 feet up in a hot-air balloon over the Loire River in France." Great! Won't others send along a card or so from your travels. Mail it to MIT Alumni Association. It should reach Ed or me eventually.

The publisher's announcement of a second edition of **Dick Muther's** book, *High Performance Planning* tells us more about Dick's professional accomplishments than his modest write-up in the reunion book or conversations at our reunion—or more than we are permitted space here. Briefly, his career spanned over 1,000 consulting and professional planning projects worldwide; author or co-author of nine books (with a dozen foreign language editions) and more than 100 technical papers; recipient of the Gilbreth Medal and several other awards from professional societies; and, finally, chairman, president, fellow or charter member of several management and materials handling associations.

For those wondering why we didn't see **Blaine Fairless** and **Charlie Henes** at the reunion, the Association has reports from their widows that they passed away in June and May respectively.

Finally, to be informed about classmates mentioned from time to time in these notes—their addresses, careers, hobbies, volunteer activities and families—do send \$25 to our class president, **Horace Homer**, for one of the remaining reunion books, nearly 160 pages of pictures and data. Horace's address: 702 Quaker Rd., North Falmouth, MA 02556.—**Don Severance**, Secretary, 39 Hampshire Rd., Wellesley, MA 02181; **Ed Haley**, Assistant Secretary, 50 Spofford Rd., Boxford, MA 01921

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Holden Withington, Jim Barton, and I were luncheon guests of Bill Hecht and Diana Strange of the Alumni Association in Bellevue during September. During lunch we learned Holden continues to fly his airplane, Jim was preparing to join reunion and gift committee classmates in September at the Cambridge fountainhead, and Hilda and I were planning to join friends to tour the rain forest on the Olympic Peninsula.

Our special thanks go to Marguerite Aiken (Mrs. **Thomas B. Aiken Jr.**) who wrote from Fort Lauderdale to correct information previously published about Tom's death: "My late husband died in November 1985 while we were living in Marbella, Spain. Tom had taken early retirement, sold his architectural firm in Fort Lauderdale, and we were enjoying travel and the freedom offered by the golden years. When we lived in Florida Tom was one of the charter members of the MIT Club here, and he had belonged to the MIT Club in Washington, D.C. . . . I would appreciate very much if you could tell me of any MIT Club activity in this area." I mailed a list of 25 '39ers who live in Florida and Marguerite responded with a beautiful thank-you note.

Tony Arias writes from Madrid, Spain, that he expects to attend the reunion this June. . . . **Sam Sensiper** continues to be active in Los Angeles with jogging, some consulting, and lots of joke-telling, as Elaine tries now and then to slow him down. They travelled to Hungary in 1986, En-

gland in 1987, and Illinois in 1988 where Sam read papers on electromagnetics and antennas. Sam says they were in Hungary shortly after the Russian disaster at Chernobyl, but they were not adversely affected by fallout. In California Sam and Elaine visit **Paul Sokoloff** and Helen. Paul is confined to a wheelchair and would appreciate hearing from classmates who can write him at 10 Cresta Verde Dr., Rolling Hills Estates, CA 90274. Sam and Elaine plan to attend the reunion and should have some good stories to tell.—**Hal Seykota**, Secretary, 1701 Weatherswood Dr., NW, Gig Harbor, WA 98335

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James Baird, class president, phoned recently to tell me that **Tyler Marcy** has accepted the chairmanship of the 50th reunion fund drive. The two of them will meet with class treasurer **Edgar Bernard** and me in the near future to go over plans for the drive. With the participation of as many of our class members as possible, let's make it a tremendous gift to MIT, of which we can all be proud.

Jim Baird also told me of his recent trip with the MIT 20th Century Group that included 10 days in Scotland, with an optional additional three days in London. The group was all MIT people or those associated with it. Jim was pleased to find **Robert Hess** on the trip. Bob is retired from IBM, and he and Nancy are doing a lot of traveling. They now live in New Jersey but will soon move to Westchester, N.Y.

Garrett Wright wrote to say that **Paul Witherell** lost his wife, Norma, on June 19. Our deepest sympathies to you, Paul. Garry also said that he has had a banner year, with no trips to the hospital except for dialysis. He also had a week-long trip to the Caribbean and a two-week trip to Newport News, Va., and Kitty Hawk, N.C.

Bruce Duffett sent a note to **Ed Bernard** to say how delighted he was to hear that Ty Marcy is to be the 50th reunion gift chairman. He is looking forward to seeing many of us at the reunion. He also writes, "I try to keep ahead of the doctors and dentists by participating on the golf course, tennis courts, and swimming pool. Also try to maintain some civic duty by working with SCORE, Rotary, and the Society of Plastic Engineers. Happy to report a family reunion this summer on Monterey Bay, Calif., with four children and spouses and 10 grandchildren." Incidentally, Ed Bernard and I are both active members in the Boston SCORE chapter. It is a great organization, and we both enjoy it immensely.

I am sorry to report the death of **Reeve Morehouse** on August 4. I have no further information.

David "Beano" Goodman sent a clipping from the *Madison (Indiana) Courier* that reads: "The Lide White Memorial Boys' Club last night honored long-time club supporter **David R. 'Beano' Goodman**. The club's gymnasium has been named the David R. Goodman Gymnasium for his many years of service and support to the club. Thomas W. Burt, regional service director, said in a letter to Goodman that 'since 1954 as a founding member of your Boys' Club corporation, you have been instrumental in the organization's growth and development. It is only appropriate to recognize your concern and dedication to the youth of your community by dedicating this gymnasium in your honor.' Goodman was presented a plaque, and another plaque will be placed over the gymnasium doors." In his letter, Beano speaks proudly of how well the organization has done over the years since he got it started in 1954. There are now 1,371 members in a rural county of only 25,000 people. His wife, Jeanette, did roughly the same thing for the Girls' Club, having run their fund drive for a new building about four years ago. After her death, the club named their library in her honor. Beano is still working part time at his Madison Chemical Co. as well as teaching a little bridge.

That great 50th reunion is getting closer all the time. Plan now so that we can all be together at the Mystic (Conn.) Hilton June 4-7, 1990.—**Richard E. Gladstone**, Secretary, 1208 Greendale Ave., Needham, MA 02192, (617) 449-2421

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The third annual Charles A. Dana Awards for Pioneering in Health and Higher Education was presented at a ceremony in New York City in November 1988. The \$50,000 awards are presented each year to individuals for their innovative ideas that improve the quality of undergraduate education. The panel, or awards jury, was chaired by Dr. Vartan Gregorian, the President of the New York Public Library and the new President of Brown University. Dr. David S. Saxon, chairman of the MIT Corporation was one of two recipients of the awards who were also named as members of the award panel. . . . **James F. Healy** is the chairman of the Florida Federal Savings and Loan of St. Petersburg, Fla.; he was formerly chairman and president of the Milton Roy Co. (retired but remains as a director).

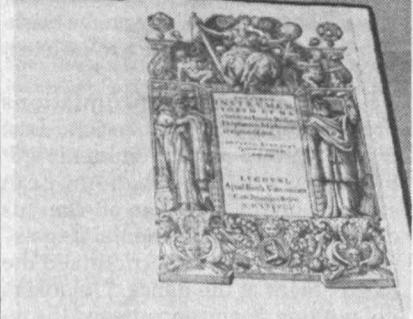
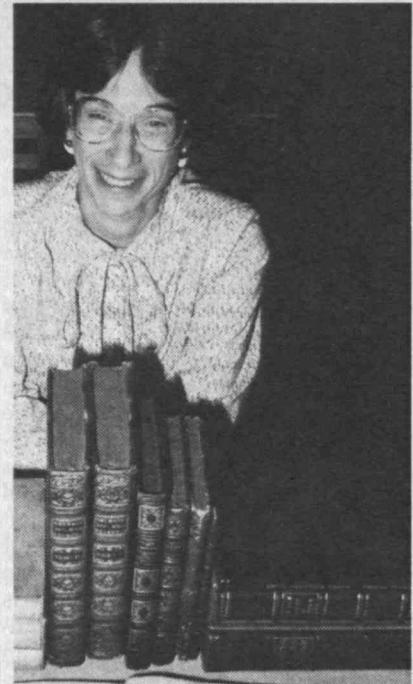
Jack Arthur Obermeyer, a retired naval architect and engineer, died July, 1988 at Stamford Hospital. Jack served in the U.S. Navy during World War II as well as in the Korean and Vietnam Wars. During his 31 years in the navy, he held several distinguished positions, including commanding officer and director of the David Taylor Model Basin in Carderock, Md., and commanding officer of the Naval Ship Repair Facility in Yokosuka, Japan. He retired in 1968. Jack received the Legion of Merit award in the Service. Survivors include two daughters and a grandson. Those of you who may like to add a personal note about Jack, please write. . . . **Bob Blake** is running for Congress, 7th District, Republican, Seattle. Your secretary received his brochure in September 1988, and will have more to tell you in the next issue.—**Joseph E. Dietzgen**, Secretary, Box 790, Cotuit, MA 02635

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We have never started class notes with an obit, but to every rule there is an exception. Just got news, by way of **Frank Seeley**, that **Charlie Stempf** died recently. Although he lived in Australia since 1964, CR kept in touch with all of us via his regular clever and well-written contributions to our class notes. He was a submariner during World War II, then worked for Worthington Pump Co., first in Springfield, MA., and then in Madrid and in Mexico City. He was later associated with Union Tank Car Co. in Chicago, London and finally in Adelaide, Australia. He will be missed by the class and particularly by his secretary. Our condolences to Nancy and to his family.

The Seeley's are still holding forth in Miami Beach but plan to move to their new home in Gainey, Ariz., in the spring of 1989. Frank retired from his position with the Dade County Public Works Department and spends some time in world-wide travels by way of military "space available" flights. . . . Newsy letter from **Bill Johnson** tells that he, and two classmates, **Fred Fleischauer** and **Clark Hungerford**, have started a new company, Pneuways, Inc., developing, designing and selling air-actuated structures to hold, and/or to convey materials by air flotation and by vacuum. That doesn't keep Bill busy enough so he is also working for his younger son (Carl, MIT '84) selling proprietary gas flow meters. . . . **Lou Rosenblum**'s consulting work is now almost entirely in the area of typographic design for microcomputers. Applications are in desktop publishing and in LaserWriter fonts for Russian and for the nine other languages using the Cyrillic alphabet.

The Honors and Awards Department has an outstanding item this month. **Nanu Amin**



A rare book by **Jacques Besson** dated 1578 is displayed by **Helen Samuels**, Institute Archivist. **John D. Stanitz**, '42, has donated to the MIT libraries this and nine other volumes on early mechanics and mathematics, including works by **Leonard Euler**, **Niccolò Tartaglia**, and **Thomas Harriot**. These are from his collection of historically important works in the areas of solid and fluid mechanics, mathematics, machinery and energetics, which he has spent more than 30 years assembling.

received the Global Energy Society's Energy for Mankind award. It is not really great news that Nanu has got another award. He has already received many of these. What is different is that Nanu was one of three awardees, the others being Dr. Glenn Seaborg from the University of California and Dr. Malu wa Kalenga from the University of Zaire. A high-class group, to be sure!

We join with the MIT Libraries in thanking **Jack Stanitz** for a gift, this time, 10 books from his collection of historically important volumes in the areas of solid and fluid mechanics, mathematics, machinery and energetics. The next installment of class notes will be penned (or word-processed) from our winter quarters in Clearwater, Fla.

A Fast to End Chill for Asian-Americans

By Susanne Fairclough

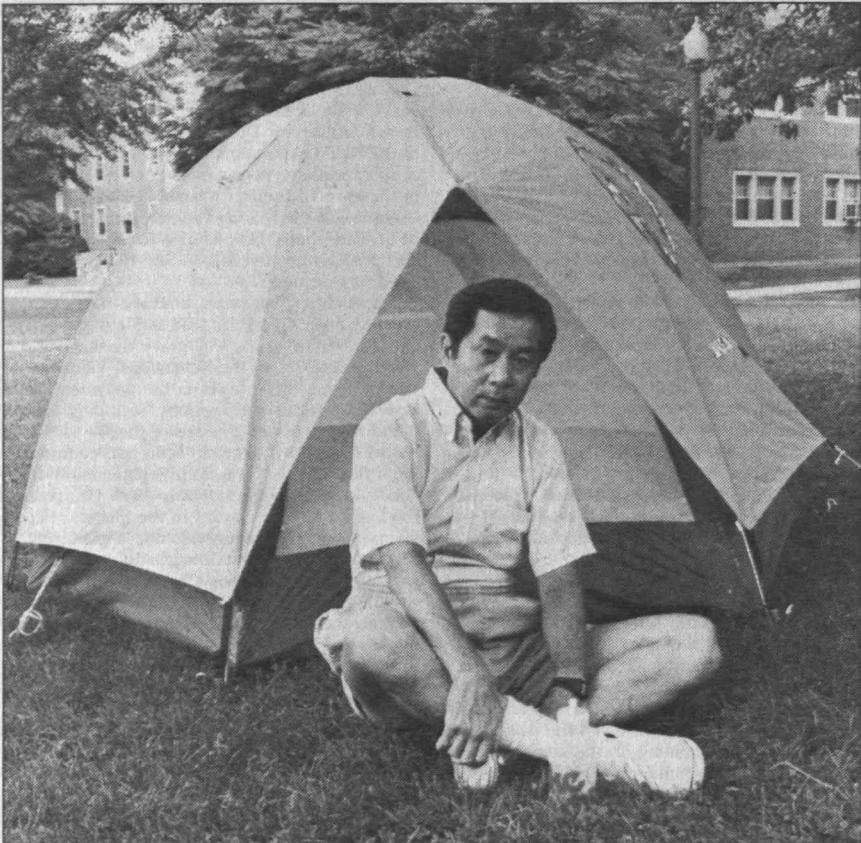
Last summer, Paul Bock, '47, set up his tent on the campus of the University of Connecticut at Storrs, where he is a professor of hydrology and water resources. He camped there for eight days, fasting on water and juices, to call attention to racism toward Asian-Americans at the university and to highlight student requests for an Asian-American studies course, an Asian-American cultural center, and an Asian-American dean.

Fasting as a form of political protest has become prevalent, but for someone of Paul Bock's background the action is astonishing. "I am the typical Asian-American professor," Bock told Jean Caldwell of the *Boston Globe* in an interview. "I have been writing on the blackboard for 20 years. I never wrote a letter, never made a speech."

Several racial confrontations propelled him to take action. Last winter a group of white students spit tobacco juice on eight Asian-American students on the way to an off-campus dance, called them "Oriental faggots" and "chinks," and then continued the harassment at the dance. Onlookers did nothing; many encouraged the attack, claims Bock. Later the university dismissed one student involved, and another was removed from campus housing but continues to play football for UConn. An equally disturbing incident occurred in 1986 when racial insults were smeared in feces on the dormitory door of a Vietnamese-American residential assistant. The university never identified the perpetrators.

After these episodes an Asian-American association was formed in protest. While UConn President John Casteen was determined to review the academic and residential-social situation of Asian-American students, Paul Bock feels the president's efforts were slowed by other administrators. No Asian-Americans were invited to be on the investigating committee, and finally Bock himself was discouraged from meeting with Casteen to voice his frustration.

Paul Bock's response was a solitary one, respectful in the tradition of Mohandas Ghandi, whom he calls "one of my greatest heroes." In an effort to



Paul Bock, '47, sitting in front of his tent on the University of Connecticut campus to protest racism toward

avoid disruption, Bock chose a time when few students would be on campus and asked permission to pitch his tent. He enlisted the aid of a campus physician to monitor his health, assuring family and friends that he would cease the fast before doing permanent damage to his body. "I make no demands on anybody. I want to send a message to the president and the administration: We Asian-Americans want to be treated as equals."

While not claiming to represent anyone else, he is not alone in his quest. Bock is supported by the campus Asian-American Association, whose president, Maria Ho, describes the situation at UConn as "chilly for minorities" and calls him an inspiration. He gained the backing of the East Coast Asian Student Union, representing groups on 40 campuses, including

Asian Americans. He drank only water and juices during his eight-day fast last summer.

MIT, whose students traveled from many colleges to boost Bock's spirits. Eventually, it was an outpouring of nationwide encouragement, including the Organization of Chinese Americans, that persuaded him to end his fast after eight days.

Bock is still optimistic about the introduction of a course on Asian-Americans at UConn. Along with two other professors, Bock is trying to form a UConn Asian faculty association to promote harmony and to provide encouragement and support to the 600 Asian students. About 20 percent of the 60 Asian UConn faculty attended the second meeting held last October. □

SUSANNE FAIRCLOUGH, formerly a staff editor of Technology Review, is now working part-time on the Class Notes.

PLEASE send news to our White Plains address; you can be sure that our friendly neighborhood post office will forward it to Florida.—Ken Rosett, Secretary, 191 Albemarle, Rd., White Plains, NY 10605

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From Bangkok, Air Chief Marshall **Siddhi Savetsila** writes that he has been foreign minister of Thailand for eight years and three months (a record?). He is currently chairman of the Standing Committee of ASEAN. . . . Marshall Waller, '46, whose hobby is salvaging scrap gold, has obtained an unidentified 1943 class ring in perfect condition, which he is willing to sell for the scrap gold price. Anyone interested may call him at his home in Potomac, Md., (301) 762-9186.

I have deciphered (sort of) a note from **Bailey Nieder** out of Seattle. He retired last spring and is now either "iking three coupons" or "hiking thru canyons"; I'm not sure which. He has three widely-scattered sons to visit, and plans to attend the 50th reunion.

George Freedman, Wayland, Mass., has authored a book, *The Pursuit of Innovation*. It has received high praise from both corporate managers and business school academics, and is a recent selection of the Macmillan Executive Program Book Club. George's entire career of 40 years has been devoted to the organization and management of innovation in large companies. His accomplishments in new product development are impressive, with a long list of patents, publications, awards and honors.

The post-reunion hiatus has set in. With five years of class notes to fill before the 50th, I'll need all the help I can get.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

44

45th Reunion

The reunion committee met on October 5, 1988, at the home of Jane and **Lou Demarkles** to continue the planning for the 45th reunion in Bermuda. We hope by now that all have received the reunion data and have or will shortly return their reservation data. June is just around the corner. If you have any questions or need further information, please contact one of the class secretaries.

Robert Oppenlander has retired from Delta Air Lines where he was vice-chairman, chief financial officer and director. He will remain as a director. . . . **Al Picardi** writes from Davis Wharf, Va., that he is thoroughly enjoying retirement. He has spent the summer golfing, swimming and playing farmer at his Holly Point Farm home. Following that in October they left for Morocco, Spain and Portugal. The joy of being over 65.—Co-secretaries: **Lou Demarkles**, 53 Maugus Hill Rd., Wellesley, MA 02181; **Andy Corry**, 16 Brimstone Ln., Sudbury, MA 01776

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As we face the new year "with renewed vigor," I suppose we should have some stories to tell, if only a few. Remember, this column depends on you as I'm running out of bio book items with which to inform you.

First off, I did get a nice letter in August from **Don Burke**, a good old XVI/V-12 comrade, telling about his and Pat's six-week trip through the Eastern Bloc, from East Germany, Slavias, etc., to "as far east as Yakutsk, Siberia, and as far south as Samarkand and Burkarha in Central Asia. All is well; no one wants to shoot anyone, and the dollar is still respected. . . . Someone equated Russia (really the Soviet Union) to a Third World country with missiles. After having traveled through seven time zones, Pat and I were amazed that the tsars ever put a nation together over that vast territory." Things are still pretty wonky, but the Gorbachev/glasnost/perestroika era is obvious-

ly loosening things up. Don has come up with a grand idea on how to raise the consciousness of the new generation(s) to history and the complex interactions of our global society. He's "established a small, private entity called the Institute Of Understanding (I.O.U.) that hopes to arrange scholarships for students who will write papers or theses or dissertations on answers to questions such as: 'How many millions of lives, thousands of cities, hundreds of cultures might have been saved if Napoleon had won?' Perhaps by our 50th reunion it will be off and running." Don's also converted a huge stack of 8mm family movies onto video tape, which sounds like a good idea for a lot of us!

In September Bettie and I had a grand opportunity to spend a sort of 30th anniversary week in Monterey, Calif., which, among other wonderful things, gave me the chance to fulfill my vow to visit with **Bob Zucker** (a Company 7 stalwart) and wife Paulie, who have lived since 1966 in that paradise we call Pebble Beach. Bob is spending his 24th—and probably final—year as a professor of aerodynamics (and a lot more) at the Naval Post Grad School in Monterey. He was a Course II scholar who went on to his S.M. at the University of Louisville (while he taught there) in '58 and his Ph.D. at the University of Arizona in '66. His textbook, *Fundamentals of Gas Dynamics*, was published in 1977. Bob and Paulie like to play tennis and bridge, and I would dearly love to live next door, if I could ever afford it!

And thumbing through the bio book for the umpteenth time I find a paper clip on a page with **Fred Ross**'s name. A Buffalo stripling, Fred joined the V-12 parade and compounded it with a Course X S.B. Doesn't say what happened right after commission/graduation, but he turned up back in Buffalo for graduate study as a marketing major. Meanwhile he spent a short dozen years in research with Pratt & Lambert (nee Pierce & Stevens). In 1957 he moved up to Carborundum as general manager of ceramic fibers and later became president. Onward and upward to Raymark (nee Raybestos) as president and CEO, and in 1985 opened his own venture capital office at home in Westport, Conn., where he presumably still holds forth. Fred and wife Joan, a practicing psychotherapist, bore six children and had about eight grandchildren at last count. They enjoy running (marathons?), tennis, skiing, hiking, and biking (anything left?), and hope to spend more time in Stowe, where they've built a new home.

Finally there's **Jack Sargent**, another youngster out of the Big Apple and transferee from Dartmouth into the V-12 Maelstrom, who got wired into his Course VI S.B. in the June segment. He picked up his S.M. at Maryland University while working at the NBS as an electronic scientist. Did a six-year stint in private industry doing R&D on central control systems before returning to the D.C. area and NASA's Goddard Space Center. Here he received NASA's Exceptional Service Medal for his design and leadership on the Orbiting Astronomical Observatory (OAO) Satellite program. Jack retired from NASA in 1979 and has since run his own consultant shop at home in Silver Spring, Md. (an old stomping ground of mine in my bachelor years). Anyhow, at last report he was involved in commercial, shuttle, and satellite instruments. He's been married for 40 years to Marilyn, who works as a writer for the National Institute of Mental Health. They have two daughters, both married. A warm, rewarding new year to you all.—**Jim Ray**, Secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

47

J. Stanley Cobb retired recently from the DuPont Co. after nearly 40 years of service.

Due to the lag in the time these columns are written and published, we haven't had time for our classmates to respond to our call for news so there's little to report this month. Therefore, let me write a bit about myself. After 25 years in in-

dustrial sales/marketing and general management with three companies (General Electric, Colt Firearms, and Applied Power Industries), I formed Remac Associates, Ltd., in 1972. We provide market research, primarily qualitative in nature, for industrial companies selling to industrial customers—really industrial opinion research. After 16 years—and my wife's retirement last year—I am now phasing into early retirement. Almost all of our work now is either for old clients or referrals; we no longer actively solicit new business. We plan to spend more time traveling in general and at our condo on Kauai in particular.—**Robert E. McBride**, Secretary, 1070 Pilgrim Parkway, Elm Grove, WI 53122

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Among the classmatters who travelled further for our 40th reunion were **Peter Notz** from Switzerland, **Humberto Leon** from Honduras, **Jim Palmer** from Washington, and from California there were Lorraine and **Carl Peterson**, Barbara and **Norman Rossen**, Susan and **Denny McNear**, Eileen and **Bill Zimmerman**, Patricia and **Bob Gates**, Phyllis and **Leo Celniker**, Mary and **Howard Brownson**, **Geraldine (Mar) Haughey** and her daughter **Donna**, Mary and **Phil Lally**, and **Alfreda and Mel Posin**.

A total of 108 classmates and their guests attended the 40th reunion on the MIT campus in early October. Thirty five classmates were returning for their first reunion in 40 years. They were pleased with the welcome they received and many of them expressed their interest in future reunions. The reunion activities extended from Thursday evening through Sunday lunch. There were eight formal presentations by speakers. Everyone was pleased to hear MIT professors who could explain economics, robotics, and mechanical design in such a way that the presentation was easily understood. In addition the enthusiasm of the faculty for what they are doing was clear to the audience and this added an important dimension to what MIT is like today.

David Vigoda arranged a fantastic meal at the Museum of Fine Arts for one evening's event. The gallery was open and we could enjoy the exhibit on preparing mummies (ancient Egypt) between cocktails and the dinner. **Eleanor and Harold Ottobrini** hosted an elegant dinner dance at Walker Memorial on Saturday night. The event was a great success because of the appearance of Walker, the beautifully served food, and the top notch band which combined to overcome the inconvenience of a heavy rain and having the cocktail hour in a separate building. **Graham Sterling** arranged a pre-reunion gathering at the Basin Harbor Club in Vermont. In addition to Graham and Judy, other classmatters included **Joan and Curtis Green**, **Maryanna and Dick Worrell**, **Charlotte and Bob Hanpeter**, **Bill Ihde** and his wife, and **Gene Winne**. They were able to play golf and tennis in addition to a boat trip on Lake Champlain to Fort Crown Point. They also visited the Shelburne Museum. The Greens and the Ihdes were accompanied by their daughters and sons-in-law.

George Clifford in his final speech as president of our class recognized the contributions of **Bob Sandman** as chairman of our 40th reunion. Bob's attention to detail helped avoid the problems that can crop up in activities arranged by volunteer committees. **Sonny Monosson** as publicity chairman prepared many mailings and implemented the mailings for our class. Sonny also served as the recipient of checks mailed for registration by classmatters. Sonny prepared and mailed copies of the registrations received to at least four other committee members. Graham Sterling worked with the art center at MIT to prepare a unique coffee mug which everyone received as a souvenir. The souvenir for the ladies was arranged by **George Clifford**, and it was a lovely crystal pendant with an engraving of the Building 10 dome. Gifts for our speakers were arranged by

George Clifford, Graham Sterling, Bob Sandman, and Harold Ottobrini. I invited the speakers to come. Herb Lipson and Al Seville provided information about tour opportunities in the Boston area. Milton Slade was a busy treasurer with a cash flow approaching \$50,000. Malcolm Read and Sonny Monosson produced a yearbook with the 100 responses sent in by classmates. Also 350 classmates returned questionnaires which were the basis of statistics about our classmates. Sonny's computer prepared correlations, and Malcolm analyzed the statistics at lunch on Sunday.

Ken Brock, Verity Smith, Stan Abkowitz, and Stan Shein also helped run the reunion. Significant support was provided by the MIT Alumni Association and Eliza Dame was their representative. Eliza was extremely helpful and attended many of our evening planning meetings. She coordinated with caterers, room reservations, registration personnel, and audio visual staff.

During the class meeting in 10-250, our unwritten bylaws were amended to provide for my election to two offices. I was elected president and will continue as secretary. Bob Sandman was elected treasurer and Al Seville was elected assistant secretary. Ken Brock, Bob Hanpeter, Harry Jones, Lou Kreek, Jack Page, Bill Weisz, Bill Zimmerman, Peter Saint Germain, Harold Ottobrini, Bill Maley, Milt Slade, and Dan Fink were elected as vice presidents. The unwritten bylaws were amended to make all past presidents of the class part of the current officers group (without a vote).

A recent issue of *Time* quoted our classmate Bill Weisz who is vice-chairman of Motorola. Bill said, "Entrepreneurs create a lot of energy, but big businesses are the only ones that are going to maintain an industrial base for this country." Bill's son was elected to the Arizona House of Representatives. His son had headed up an organized crime strike force for the Arizona attorney general. . . . Sydney Crook was reappointed to the planning board of New London, N.H. He had served a five year term. . . . Duane Rodger died at home in Coraopolis, Pa., in September. He had leukemia for over a year but never gave up. Bob McBride, '47 and Duane were roommates at Tech, and Bob writes that "Duane continued working and maintaining his normal life style as much as possible up until only a few weeks before his death. Remarkably, he also maintained his usual optimistic and enthusiastic outlook on life right up to the end!" Duane was one of the finest men Bob has ever known and also one of the most courageous—he never "surrendered" to the leukemia. Duane worked for Dewey & Almy and General Electric and had been with Raychem for over 26 years when he died. Duane held a variety of sales, marketing, and training positions. He personally trained many of the company's sales people from all over the world. Raychem endowed a four year scholarship, dedicated to Duane's memory, for a deserving medical student planning to specialize in oncology in general and leukemia in particular. Duane is survived by his wife, Jo, three children and two sisters. On behalf of our classmates, I extend our sympathy to his family.—Marty Billett, Secretary, 16 Greenwood Ave., Barrington, RI 02806

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40th Reunion

James Power Gordon, a physicist at AT&T Bell Laboratories in Holmdel Township, N.J., has been elected to the National Academy of Sciences. This honor, according to a July issue of the *Ashbury Park Press*, "is generally considered second only to the Nobel Prize as a measure of original scientific achievement." Jim's recognition by the Academy comes after a career studded with notable accomplishments. He has been recognized for research in the field of quantum electronics and in electromagnetic waves.

As a graduate student at Columbia University in the 1950s, working under Charles H. Townes,

he designed and built the ammonia maser which marked the beginning of laser science. Townes won the Nobel Prize for the maser and laser and later publicly credited the discovery to the 'triumph and glory' of his student.

Jim developed the first general theory of quantum noise limitations in optical communications. Recent work has added to the understanding of how atoms and small transparent particles are trapped in the focus of convergent beams of light, and of how lasers can be built to produce pulses of light shorter than 10 femtoseconds. (Ten femtoseconds is the time required for light to travel one ten-thousandth of an inch.) Jim has also helped to explain how certain stable pulses of light called solitons might be used to improve long-distance communications over glass fibers.

Lest one conclude that Jim never leaves the lab, it should be noted that he is a past national platform paddle tennis champion (1959) and is still winning tournaments. I am indebted to Jim's wife, Susanna, for sending me the clipping on which the above is based.

At a retirement banquet at the Faculty Club recently, James Cattell was among 27 persons honored for their years of service to the Draper Lab. Jim had spent 33 years with the group where his responsibilities included airborne flight and fire control systems for both conventional and vertical takeoff and landing aircraft. Since divestiture from MIT in 1973, Draper Lab has honored 333 retirees at similar ceremonies.

Andy Bigus writes "My portfolio management activity is gradually building." Andy has a golden rule he goes by—to make it, you must first be sure not to lose it. To this end, he points out, he had 90 percent of his clients' funds out of the stock market on Black Monday, October 19, 1987.

Back in May, I reported on the election of Dick Pitler to the position of vice-president of the International Society for Metals. Now, having served for a year as vice-president, he has been elected to the presidency. The news release states that Dr. Pitler is retired as senior vice-president and technical director of Allegheny Ludlum Corp. and general manager of its Special Materials Division. One name which keeps popping up in the news is that of Bruce Campbell (I've written about him in this column twice previously.) Some of you may recall that Bruce was commissioner of the Massachusetts Department of Public Works back in the seventies and not stranger to the newspaper-reading public. Now, he has been named to the Massachusetts Advisory Board of the American Automobile Association. Bruce heads in own consulting firm specializing in transportation.

Your reunion committee toils steadily towards the June 8 to 11, 1989 dates of our 40th reunion. On September 25, the gift committee (Nell Eaton, Eunice Schneider, and Jeanne Lambe with husbands trailing dutifully behind) made a pilgrimage to the Town of Holliston, Mass., where, rumor had it, a wood-working artist of renown would, for a fee, create one-of-a-kind objects of art to be given, at no charge!, to those attending the reunion. The man's work was indeed lovely but the committee will study many items before making final choices. (Gifts for the men will be different from those for the women.) You'd be surprised how much work goes into just this one facet of our reunion.

Meanwhile, Tom Tooley down in Greenwich, Conn., is doing an outstanding job in spearheading the large, nationwide committee charged with raising our 40th reunion gift to the Institute. He, and all of his people, need all the generous help we can give them. Be cordial when someone calls.—Fletcher Eaton, Secretary, 42 Perry Dr., Needham, MA 02192, (617) 449-1614

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John H. Bickford is under contract to produce a second edition of his book on bolted joints. He is heavily involved in the use and installation of

threaded fasteners for many industries. His main hobby is painting (mainly landscapes) and is planning on semi-retirement this year to spend a larger percentage of time with his painting which is so important to him. He will still maintain 30-40 percent of his time consulting with his present employer, Raymond Engineering. . . .

Ken Eldred is very interested in sailing and has recently invested in a high performance hull and rig for use in extended cruising. He hopes to spend more of his time on this hobby. His wife runs an ISIA Figure Skating Program for 80-100 children. . . . Vernon Ellenberger spends a great amount of his time in volunteer projects. He is the business manager for the non-profit community newspaper (*Greenhills Forest Park Journal*, Greenhills, Ohio). He also tutors math in the local Catholic Elementary School. . . . Donald Germaraad retired to a Douglas fir tree plantation on Mt. Underwood, Wash., with a beautiful view of Mt. Hood in the scenic mid-Columbian Gorge area with excellent hunting and fishing. He spends a portion of his time as a mission search and rescue pilot for the Oregon wing of the civil air patrol giving aeronautical lectures when not busy flying on Air Force missions. He continues to be active in church affairs.

John Malloy has a book in preparation: *A Primer on Security Analysis for the Average Investor*. He is also the president of Chorus of the Dunes; a local chapter of the Society for the Preservation of Barbershop Quartet Singing in America. He arranges music for barbershop quartets.—John T. McKenna, Secretary, 9 Hawthorne Pl., 10-H., Boston, MA 02114

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On September 18 our 40th reunion gift committee sponsored a gathering of our classmates from the greater Boston area at Carole and Dick Reedy's lovely home. Many of you will have fond recollections of their home as the site where we had our 35th reunion clambake. About 40 of our classmates and their wives were there. The gathering combined a pleasant social afternoon with thought provoking session. Reunion gift chairmen Bill Maini and Marv Grossman explained the current thinking of the committee is specifying a direction as to how our 40th reunion gift should be used. The goal would be to have the funds used in directions that would advance the teaching capabilities of MIT's undergraduate program. While there was a generally positive reaction to the proposals, there were many constructive comments on how to best handle the problems that might be encountered in realizing this objective. The committee will be attempting to use these thoughts in refining their proposals and to present them to you shortly.

Recently named Presidential Professor at the Ohio State University, George R. St. Pierre is only the third person to receive this permanent appointment. It is based on comprehensive excellence in research, teaching, and service to the University. Currently chairman of the Department of Metallurgical Engineering, George has been designated to chair the newly formed Department of Materials Science and Engineering. He has received the ASM International Gold Medal and the AIME Mineral Industry Educator award. He was named University Scholar during this past year. One of his four children provided him with an equally gratifying award, a nine-pound girl as his first grandchild. George writes that he is looking forward towards attending our 40th reunion.

Celebrating the 25th anniversary in architectural practice of his firm Rothzeid Kaiserman Thomson & Bee, Bernard Rothzeid has been a recent recipient of the highest architectural award given by his other alma mater, Cooper Union. Bernard started with a two year Fulbright in Rome before spending seven years with I.M. Pei and partners. His own firm, founded in 1963, has done work in housing, health facilities, theaters, and education-

al and commercial efforts. The firm has won numerous awards including a national award from the American Institute of Architects. For many years Bernie has been on the board of the Methodist Hospital of Brooklyn.

I am sorry to have to report of the passing of **Emanuel S. Criscone**. Majoring in aeronautical engineering, he was the founder of the Kamen-Avidyne Corp., a division of the Kamen Corp. He was a member of the Greater Boston Real Estate Board and a charter member of the Quail Creek Country Club of Naples, Fla. We wish to express our condolences to his wife, Angelina.—**Martin N. Greenfield**, Secretary, 25 Darrell Dr., Randolph, MA 02368

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Howard Ferris, a resident of Concord, Mass., died last August 6, aged 73. He had attended both Northeastern and MIT. Before World War II he was an electrical engineer with Boston Edison. His wartime service with the U.S. Navy was spent in the Pacific and as a radar instructor in Corpus Christi. From 1945 until his retirement in 1971 he was an electronics engineer at Hanscom Field specializing in radar and communications. He held several patents, including one for the first electronic tube tester. He is survived by his wife Dorothy, three sons, and 10 grandchildren.

After a drought, someone has organized a comparative flood of news, for which I am very grateful. Several classmates have described their pastimes, and they are often impressive. For example, **Clarence Carson**, in addition to bicycling and skiing, both downhill and cross country, likes to hike and trek. He has done this in the Sawtooths of Idaho, the Himalayas in Nepal, the Andes in Peru, and around Mt. Kilimanjaro in Africa. Also energetic, **Bob Damon** says that he swims, jogs, and runs for fitness, and occasionally participates in 10,000-meter and 10-mile runs and 1.5, 40k, 10k triathlons. He also plays tennis. He likes to travel, and serves as an educational counselor for MIT. **Dirk Plummer** has taken to flying. He has a first class medical and commercial pilot's license with multiengine and instrument ratings.

Not everyone claims to be so strenuous. **John Crowe** likes photography and Civil War history. **Paul Lux** is vice-president and member of the board of directors of the St. Louis Zoo Association. **James Dorsey**'s hobby is bookbinding. He estimates he is one of only 200 amateur bookbinders. He also edits the Binders' Guild newsletter with a circulation of 50 in North America and Europe. **Paul Shannon**'s hobbies are photography, duplicate bridge, and bowling, but his serious pastime is genealogy and associated software development. He also mentions that he holds three patents for integrated circuit design.

Mike Nacey writes that he and his wife Jane enjoy traveling in England, France, Italy, Bermuda, and the Caribbean. He plays a good deal of tennis, and recently reached the finals of a New England Lawn Tennis Association doubles tournament. He says that "raising a five-year old daughter is an unmitigated joy."

John Fitch's children are grown, and he and his wife are retired, so he has moved, after 36 years, from Concord to a condo in Cambridge. He still does occasional consulting for the Association for Media-based Continuing Education for Engineers that he used to head, and at the time he wrote he was planning a hiking trip to the Japan Alps, combined with a visit with his son who is in graduate school in Tokyo. Afterwards he intended to join his brother for two weeks in China, their birthplace.—**Richard F. Lacey**, Secretary, 2340 Cowper St., Palo Alto, CA 94301

last time. The material that follows was received in response to a survey, so the items do not include an address or only a partial reference.

Ray Dietz indicates that he has had fun working as commissioner of the Scholastic Competition for Academic Excellence program involving high schools in Martinsville and the surrounding counties. He also spends a great deal of time visiting his four grandchildren and traveling in Europe.

Jim Fenske reports that he has traveled extensively, visiting over 40 states and more than 30 foreign countries. . . . **Chuck Forman** started a new business in September 1987. He is working in areas of business and technology evaluation and assessment, domestic and international, market research, etc. He is doing well thus far. He is still active in the Educational Council for Darien and New Canaan high schools and has been for almost 30 years.

Dave Klepper stayed on at MIT after we left and got a master's degree. He later worked for Bolt, Beranek and Newman until 1971. Then he formed a company with two partners which specializes in the acoustics of churches, synagogues, old theaters and movie houses converted to performing arts centers, airports and other transportation facilities. He is still single but has a steady girl friend. He is quite interested in railroads, urban transit, electric railroads, and railroad history. In his business, he has many opportunities to travel in the United States, Canada and the Near East.

Mandy Manderson reports that he and his wife have been working extensively in Third World countries on a consulting basis. They are currently considering taking some vocational courses to prepare them to offer local assistance at the grass roots level. They are hoping to start this new effort in 1989 or 1990. . . . **Jim Mast** writes that he and his wife participate in archaeological expeditions in Central America as volunteers. They also have a home in Guatemala. . . . **Louis Peralta** reports that his family has scattered, two sons in New Jersey, one in Dallas and one daughter, soon to be married, will move to Los Angeles.

Mark Schupack has been active at Brown University: chairman of the Economics Department, 1969-74; associate provost, 1978-82; and dean of the graduate school, 1993-86. There was no indication in the item I received what Mark has been doing since then. So Mark, if you read this, let us know what you have been doing recently and I'll pass it on.

By the way, anyone who has comments or suggestions regarding this column or the next reunion (think reunion in 1983), or pre-reunion meetings (in St. Louis, maybe, or Las Vegas)—please drop me a line and sound off. I'm waiting to hear from you all.—**Gilbert D. Gardner**, Secretary, 1200 Trinity Dr., Alexandria, VA 22314, (703) 461-0331

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35th Reunion

We hope that you have your calendar marked and plans made; as everyone should know by now, our 35th reunion will be June 8-11, 1989. The committee is meeting regularly and plans are falling into place. If you haven't received the notices from **Bob Warshawer**, please let us know right away.

Shel Dick sent a note from Europe, where he is an officer of the commander-in-chief, U.S. Army Europe Retirees Council. Shel has been awarded the Silver Beaver by the Transatlantic Council of the Boy Scouts of America for distinguished service of an exceptional character. The Silver Beaver is the highest award that can be given by a BSA Council. Congratulations, Sheldon! . . . **Ari Miliotes** writes that he will provide gourmet cheeses, crackers and accompaniments for the reunion, if our winemakers **Don Sama** and **Don McGrath** provide wine. How about it, Don and Dom?—**Edwin G. Eigel, Jr.**, Secretary, 33 Pepperbush Lane, Fairfield, CT 06430; **Joseph**



Ken Olsen, '50, was elegantly simple in explaining his philosophy after being named Manager of the Year by the National Management Association. "Interesting jobs, committed people who follow through. This leads to a very productive group of workers," he said in an interview reported in the Boston Herald.

The founder and president of Digital Equipment Corp. noted that it's important for employees to realize that there are no job guarantees. "The work will be there as long as we are the best around," he said. Olsen firmly believes in letting the employees in charge of a specific program propose how it should be carried out. "This way they feel more in control and any credit goes to them."

P. Blake, Jr., Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

55

Lots of '55ers news tidbits this month, from classmates we haven't heard from for a long while, thanks to returns from an MIT questionnaire sent to some of our class.

A. Lee Zuker reports a significant interest in classic car collecting. . . . **John Zimmer** says his family is growing with two married daughters and a grandson. He is proud to report that his second daughter received her M.S. in molecular genetics. Gardening and model trains help him to relax. . . . **Michael Wislotski** was formerly moderator at the Burlington Congregational Church and is currently a member of the chapel choir. He visits a new country each year to photograph antiquities including Poland, Peru, Egypt, and China over the last four years.

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Another issue of *Technology Review* has come around and I have a lot of material left over from

Harlan Walker reports he has been ill with chronic Epstein-Barr virus for the last two-and-a-half years and that there is presently no effective treatment for it. . . . Eldon Reiley was a visiting professor at Shanghai Institute of Foreign Trade, where he taught American commercial law and bankruptcy (law I hope!) to Chinese graduate law students. . . . Martin Raab was named, a few years ago, a fellow, American Institute of Architects, for pioneering work in the specialized design of research laboratories and high technology buildings.

David Peterson has been awarded two patents for devices to skim floating materials (oil) from water surfaces. His hobbies include flying and aerial photography. . . . Ely Lurin says he is involved in marketing high technology products and bringing new products to the market place. He has spent time on the Education Council interviewing prospective MIT students and found that experience quite rewarding.

Elisha Huggins reports that his family has been quite involved for the last few years with the Macintosh computer. Anne runs the Macintosh demonstration center at Dartmouth, and Elisha is working on the modems and software to turn the Macintosh into a laboratory oscilloscope (MacroScope tm). His daughter Cleo designed the Sonata (tm) font for Adobe Systems (for music publishing). Their son Robert has stayed away from computers; instead, he hikes and has acquired a cement yawl.

Ernest Blake is a registered engineer (mechanical) in the state of California and involved in real estate investments and operations. . . . Eduardo Elizondo has recently married after a lifetime (until now) of bachelorhood and says that his free time has dwindled significantly! Eduardo has been active for many years in the MIT Club of Princeton, N.J., and currently handles their mailing list. He works in commercial communications satellite manufacturing as a communications systems engineering manager, which requires frequent trips to Ariane launch site in Kourou, French Guiana—in view of infamous Devil's Island.

Announced in *MITRE Matters* last June was the retirement of Melvin Weiner, who was a member of MITRE's technical staff.

What fun to hear from so many of you! Thank you! I saved a few notes for DuWayne to use next month, so he can have a full column as well. Maybe this flurry will encourage others to send along notes. We can't write columns without them.—Co-secretaries: DuWayne J. Peterson, Jr., 201 E. 79th St., New York, NY 10021; Robert P. Greene, 37 Great Rock Rd., Sherborn, MA 01770

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Our president, Ron Masser, phoned to keep us abreast. Professor John M. Deutch, '61, MIT provost, informed Ron that Professor Daniel E. Hastings will serve as the Class of '56 Career Development Professor for two years beginning September 1988. Professor Hastings is an associate professor in Aeronautics and Astronautics. Professor Deutch notes, "In addition to his record of research, Daniel has developed a new subject area investigating the interaction of spacecraft and the environment." Ron adds a personal note of endorsement for the selection: Professor Hastings served as his son Christopher's (a junior in aeronautics and astronautics) faculty advisor. Ron adds, "Sometimes it is difficult to access in advance the benefits which our collective gift can bring to us as well as to the MIT community."

We are halfway towards the 35th reunion. Reunion talk is already in the air. Let Ron or your secretaries know how you would like to participate. The success of our last reunion resulted from your participation.

Irwin Dorros, executive vice-president of technical services at Bellcore (Bell Communications Research), hasn't seen most of us since the 30th and is looking forward to saying "hi neighbor" at

the 35th. He says, "I get to MIT a couple of times a year, and as I get older I find the ties get stronger." Bellcore is the research and development arm of the seven divested AT&T companies. They employ 8,000 persons with a budget of over \$1 billion. Irwin's company is investing in HDTV research, using fiber optic transmission to provide full quality. This proves an exciting activity, as Irwin is chairman of the Systems Subcommittee (blue ribbon industry group) to the FCC. The new standard, first in 40 years, will significantly improve television.

Peter Griffith, at MIT, received a grant from the Department of Energy on the order of \$200,000 for "Avoiding Water Hammer/Fluid Transients in Nuclear Piping Systems by Controlled Filling."

Trust that this year will be the best ever for us all. Keep communications a-humming.—Co-secretaries: George H. Brattin, 39 Bartlet St., Andover, MA 01810, (508) 470-2730; Irwin C. Gross, Sweets McGraw-Hill, 1221 Ave. of the Americas, New York, NY 10020, (212) 512-3181

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Depending upon when you receive/read this issue, let me be the first/last person to wish you a wonderful new year. For those of you who don't keep track of such things, let me remind you that later in the spring many of us will gather at MIT and perhaps elsewhere for our—are you ready for this?—30th reunion. I've already spoken to a number of classmates and all are planning to attend. Hope you are too. . . . One of those I've seen recently was Dick Hall. He and Landa sported me to a fine dinner in Los Angeles a week or so ago and tell me they are already planning their trip back east for the alumni gathering. Of course, they have more than one reason for the trip: their younger son, Jeff, will graduate from Colby the week before. It may be something of a family reunion as older son, Rikki, is spending the year in the Boston area as a budding musician. Reunion Committee take note. Incidentally, if you do have any ideas for the reunion, why not let me or Art Collias know. We'll be pleased to relay your thoughts to the Committee.

Two other items. Alan Barr is the chairman of the English department at Indiana University Northwest; he was just promoted to the rank of full professor there as well. Also, my old labmate, now "Professor" Jim Piper of Simmons College, has just received the college's 1988 Award for Teaching Excellence. The award is given annually to a member of the college's undergraduate faculty who is recognized as an exceptional teacher. He must have learned patience tutoring classmates like me many years ago. Jim has been at Simmons since 1966.

On a sadder note I must report the death of William F. Burke. His widow, Marnie, reported that Bill passed away in June following surgery. Bill and Marnie lived in Baton Rouge. Some of you may recall seeing them at the 25th back in '84.—Ron Stone, Secretary, 116 Highgate Pl., Ithaca, NY 14850, (607) 257-2249

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There are just a few news items this month. I really do need your help if you want to see a '60 column monthly. Please make a New Year's resolution to support both your class secretary and the Alumni Fund in 1989. Happy New Year!

The *New York Times* reports that Bob Gurnitz has resigned as president of Bethlehem Steel's Shape and Rail Division to become President and CEO of Webcraft Technologies, Inc. in North Brunswick, N.J. Best wishes from all of us, Bob. . . . From the *Wall Street Journal* I've learned that Ken Reinschmidt has assumed the presidency of the Advanced Systems Development Services Division of Stone & Webster in Boston. Congratulations, Ken!

That's it for this month.—Frank A. Tapparo, Secretary, 15 South Montague St., Arlington, VA 22204

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John A. Rollwagen, chairman and chief executive officer of Cray Research in Minneapolis, has been named a director of Apple Computer, Inc. The announcement was made in a news article in the *New York Times*, May 12, 1988. . . . Robert Barthélémy, director of the space plane program at Wright Aeronautical Laboratories in Dayton, Ohio, spoke to the MIT Club of Southeastern Massachusetts on May 16, 1988. The subject of his talk was the program he directs; to design a new space vehicle that will carry 10 to 30 people and cruise at speeds of 20,000 mph at altitudes of 200,000 to 300,000 feet. The space plane should have the capability of flying around the world in less than one hour without refueling. Talk about jet lag?

William D. Bloebaum, Jr. has been elected corporate treasurer by Mead Corp, the forest products and electronic publishing firm headquartered in Dayton, Ohio. Bill joined Mead Data Central, a subsidiary of Mead Corp., in 1984 and had been serving as the subsidiary's senior director and financial vice-president since June 1986. After graduating from MIT with an S.B. in chemical engineering in 1962, Bill went to Stanford for an M.B.A. He worked in Columbus, Ohio, for Accuray Corp. for 13 years prior to joining Mead in 1984.

It is a real pleasure to see so many of our classmates making truly significant contributions to science and technology. I guess that is what an MIT education is all about, and our classmates are doing their best to keep MIT graduates at the forefront of progress.

Our classmates in Dayton, Ohio, and Minneapolis, Minn., seem to have been in the limelight this month. What news do you have for the 1962 class notes?—Hank McCarl, Secretary, P.O. Box 352, Birmingham, AL 35201-0352

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The ultimate milestones in life are birth and death, and this month I have both to report. I regret to announce the passing of our classmate Jin H. Kim. Jin departed on March 27, 1988. He has been living at 9 Blackburn Lane, Haverford, PA 19041. Jin left his widow, Young Ja Kim, but I have no further information about children he may have left, nor of the circumstances of his passing. Classmates who knew him, and those of us who shared an affiliation with him, share Ms. Kim's loss.

I am pleased to announce the birth on August 24, 1988, at 9 lbs. 4 oz., of Julie Marcus Marsden. Julie is living with Linda and me as part of a process through which we will adopt her formally in the spring. She has piercing blue eyes and a full head of dark hair, although she is losing the hair. At age 46 it feels a bit strange to me but quite gratifying to be starting to bring up another baby. My wife Linda is ecstatic. My son Gary, who is 18 and who was an only child, thinks it's Jim dandy to have a sister. He is majoring in cognitive psych (at Hampshire College) and can't wait to use her as an experimental subject.

I also have two retirements to announce. Lincoln Clark, who obtained his S.M. in nuclear engineering in 1963, and who is thus in a sense part of our class, retired recently after 30 years' service with the Institute, most recently as associate director of the Nuclear Reactor Lab. Some of us may also have had occasion to meet another recent MIT retiree. He was not a member of our class, but regularly met members of our class in the course of his duties. Jim Olivieri—former head of the campus police—has retired, also after 30 years of service.

George Bryant, who received his B. Arch.

degree as part of our class, is active in community affairs in Provincetown, Mass., where he grew up. Most recently, it is reported, he lectured at the American-Portuguese Genealogical and Historical Society annual meeting on "The Folks of Provincetown, Then and Now." George has been a member of the board of selectmen, the planning board and board of health, and is Provincetown's representative to the Cape Cod National Seashore Advisory Commission. I understand there has lately been quite a debate over development of Cape Cod, so I imagine George has been quite busy.

MITRE Corp. reports that classmate **Mike Harris** has been appointed chief engineer of its Washington C3I Division. Mike has been with MITRE over 20 years, since getting his doctorate from Stanford. Besides C3I, Mike has worked in air traffic control and information systems.

Fellows and gals: it's cold outside, so warm up your word-processor, typewriter or telephone and send me some hot info to share with our classmates. Thanks for your support.—**Phil Marcus**, Secretary, 3410 Orange Grove Court, Ellicott City, MD 21043 (301) 750-0184

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25th Reunion

The newsbag is pretty thin this month; just a few items, which I'll supplement with a brief preview of plans for our 25th reunion.

John Clarke has begun new duties as director of Medical Services at Weirton Steel Corp. He has been with Weirton since 1981. John is a Course VIII graduate who went on to earn a Ph.D. in physics from Cornell University and an M.D. from the University of Miami. He is board certified in emergency medicine and is a Fellow of the American College of Emergency Physicians. He lives in Paris, Pa. . . . **Ron Cordover**, a member of the Class of '64 who received an S.B. and S.M. in 1965 and a Ph.D. in 1967 (all in Course VI) is now chairman of Berkline Corp. of Morristown, Tenn. He remains as president of Science Applications, Inc., of Wayne, N.J.

At a recent conference on technology transfer held here in the D.C. area, I met **Bill Ribich** who is a vice-president with Foster-Miller, Inc., in Waltham, Mass. Bill is a Course II grad who went on to earn an Sc.D. He's living in Lexington. . . . From **Bill O'Halloran** comes news of the plans of our reunion. As previously mentioned, we will be headquartered at the Cambridge Center Marriott. On Thursday, June 8 we will be starting off with a buffet reception at Symphony Hall prior to Tech Night at Pops. Throughout the weekend, there will be intellectual stimulation, chances to eat together and share memories, and what Bill describes as "one helluva good time." (From personal experience, I can vouch for the fact that Bill is an excellent judge of what constitutes "one helluva good time.") By now, you should have received an information packet concerning the reunion. Please remember to send in the questionnaire and profile—even if you aren't planning on attending. Best wishes to all for a happy and healthy 1989!—**Joe Kasper**, Secretary, 3502 Idaho Ave., NW, Washington, DC 20016

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I complained about last month's column! The entire package for January is a newspaper clipping that mentions **Jeff Meldman**'s participation in a conference on the development of artificial intelligence in Massachusetts. The conference was sponsored by a committee of the Massachusetts Senate. Jeff stressed the need to guide the evolution of legal doctrine in areas of liability, crime and intellectual property. Jeff's a senior lecturer at the Sloan School and associate dean for student affairs at MIT.

Happy New Year, all. I'm still looking for a replacement.—**Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

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Since the news backlog has almost disappeared, please help beef up these notes by writing or telephoning. I especially welcome personal visits, with or without notice.

Michael Mark has been promoted from director to vice-president of systems integration for Interleaf, Inc., of Cambridge, Mass. . . . **Richard Simpson** is a senior research associate at Stanford University's Center for Radar Astronomy. Dick has been involved in several Mars radar studies and in *Voyager* experiments at Saturn and Uranus. In his spare time he is an outing leader for the Sierra Club and a member of the California Parks and Recreation Department's SnoPark advisory committee. He spends weekends in Davis with his close friend of five years, Ann, and her mildly eccentric dogs, Taj and Barley.—**Jim Swanson**, Secretary, 878 Hoffman Terrace, Los Altos, CA

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Few items in our backlog, so we hope things pick up with the fall's Alumni Fund mailings. But remember, you can always write directly.

Paul Forbes sent his regrets that he missed the reunion but "finds it incredible that graduation was 20 years ago." He adds, "If the swift passage of time is an indication of enjoyment, then my life since graduation has been a joy." . . . **Richard Raysman** has been elected first vice-chair of the banking, corporation, and business law section of the New York State Bar Association. His New York City firm, Brown, Raysman & Milliken now has 17 lawyers concentrating in high technology law. . . . **Bruce Cregger** has been named an associate partner of the Boston firm of Haskins Scott Taylor and Partners, architects and planners. . . . **Tom James** has been promoted to vice-president of marketing for the Blount Construction Group of Blount, Inc. He has been with the firm since 1983. Prior to joining Blount he served as regional manager of business development for ORBA Corp. in Houston and was involved in management and engineering with Shell Oil for eight years. He and his wife Jane have two children.

Looking forward to hearing from you.—**Gail and Mike Marcus**, Secretaries, 8026 Cypress Grove Lane, Cabin John, MD 20818

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20th Reunion

Remarkable, folks! After inundating me with notes all year, a month with not a word from classmates—at least not on paper. There is news, however. Your trusty 20th reunion committee has cranked up, and many of its members met recently (9/88) at the Hyatt Regency Hotel in Cambridge to plan festivities for this June. Attending were **Ross Hunter**, **Jeff Lepes**, **Laura Peterson**, **Ray Smith**, **Robert Wiener**, and yours truly. By now, you all should have received our preliminary mailing or mailings asking you to come to the Big 20th, June 8 through June 11, 1989. Please come to our reunion! Even if you missed the 5th, 10th, and 15th, why not come to this one, now that your mid-life crisis is over—or perhaps just beginning! Have it with friends.—**Eugene F. Mallove**, 183 Woodhill-Hooksett Rd., Bow, NH 03301

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Jeffrey Burke Satinover, M.D., has been appointed medical director of Temenos Institute. He is the executive director of the Sterling Institute for Neuropsychiatry and Behavioral Medicine in Stamford, Conn. A former fellow of the Yale Child Study Center, he is also clinical assistant professor of psychiatry at the Yale University School of Medicine where he received his training in adult psychiatry. He was twice recipient of

Yale's Seymour L. Lustman Research Award in Psychiatry. He received his medical degree from the University of Texas and completed psychiatric training at the C.G. Jung Institute of Zurich, Switzerland. He and his wife, Julie, have a daughter, Sarah Katherine. . . . **L. Scott Ramos** writes: "After three years performing natural products research in the Amazon, I returned to Seattle without a job, so I took advantage of some freedom and entered graduate school. I didn't anticipate how hard it would be to retrain study habits. This spring, I finally finished my Ph.D. in chemometrics and analytical chemistry and now work as senior scientist at Infometrix in Seattle.

Adrian Bejan, professor, department of mechanical engineering and materials science at Duke University, will receive the Gustus L. Larson Memorial Award of the American Society of Mechanical Engineers. The award is given to an engineer who has demonstrated outstanding achievement in mechanical engineering within 10 to 20 years following graduation. Dr. Bejan has written three books, *Entropy Generation through Heat and Fluid Flow* (Wiley, 1982), *Convection Heat Transfer* (Wiley, 1984) and *Advanced Engineering Thermodynamics* (Wiley, 1988). He received his S.B., S.M. and Ph.D. degrees from MIT. . . .

Thomas D. Halket, a partner in the New York city law firm of Scheffler, Karlinsky & Stein, is the chairman of the American Bar Association's section of Science and Technology.—**R. Hal Moorman**, Secretary, Box 1808, Brenham, TX 77833

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Gerald Billes' firm, Billes Manning, was recently chosen to design improvements and an expansion of the New Orleans International Airport. . . . **James Daniels** is a teacher at Haddam-Killingworth High School in Connecticut. He has taught there for the last 12 years and has also served as an instructor in drug rehabilitation, Upward Bound, and Project Learn programs; and as president/negotiator for the Haddam-Killingworth Education Association.

No more news for this month—write more, please!—**Dick Fletcher**, Secretary, 135 West St., Braintree, MA 02184

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No great amount of news this month to shake the earth, however an article was passed on to me about **Daniel Greenbaum**, who was recently named commissioner of the Massachusetts Department of Environmental Quality Engineering. Daniel was named to the post this past April, after a nine-year tenure with the Massachusetts Audubon Society, concluding as its vice-president. . . . **John Wurts** has been named chairman and CEO of Symbolics, Inc., of Cambridge, leaving as president of Management Decision Systems. . . . **Nicholas Hamisevitz** reached his fifth year with the MITRE Corp., where he is a member of the technical staff.

That's about it folks. The pool is in, our older son Eric ('96) is playing offensive tackle for his high school team, JR ('03) is decking classmates who cross him, and the little lady has become a 175 bowler. Where were the Olympics when she got good? Write!—**Robert M.O. Sutton, Sr.**, Secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

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Only two items this time: **Mitchell G. Tyson** left GCA to become vice-president of operations for Precision Robots, Inc., of Woburn, Mass., a \$10-million company that manufactures automation systems for the semiconductor and pharmaceutical industries. (Could you please make a model to clean my home and sort my mail?) . . .

DAEDALUS

HOW TECHNOLOGY RECREATES A LEGEND



THE STORY OF
MIT'S TRIUMPHANT
DAEDALUS PROJECT
IS NOW AVAILABLE
IN REPRINT FORM

On April 23, 1988, after three years of planning, testing and perfecting technology, a 70-pound aircraft called *Daedalus* was pedaled 72 miles from Crete to the island of Santorini—breaking the record for human-powered flight.

John Langford, the project manager for the journey across the Aegean, tells how his team combined technology with perseverance to achieve this new world record.

Because of the popularity of Langford's article, it is available in reprint form. Considered by many to be the most in-depth article on the subject, it allows you to relive this historic event. The reprint is filled with stunning full color photographs that capture the making of the flight.

Our fearless president, **Milton Roye**, reports that 10th reunion activities are continuing on the West Coast in Stanford's back yard. **Steve and Libby (Seifel) Melnikoff** lent their back yard, deck and waterfall for the party, attended by 20 classmates, nine significant others, and four members from the MIT classes of 2006 to 2010!

In addition to Milton and Steve and Libby, **Tom Mattison**, **Herman Marshall**, **Kendall Jensen**, **Scott Westbrook**, **Guido Hayman-Haber**, **Jim Fenton**, **Bob Twaalfhoven**, **Al Frazier**, **Erika Williams**, **Lee Gavens**, **Brad Albom**, **Dave Potter**, **Bob Bluhm**, **Doug and Sharon (Pastoriza) King**, **Farid Dowla**, and master poster designer **Rich Perlstein** were in attendance. A champagne brunch under a beautiful September sky and no problem sets in sight made the memories of the Tute quite poignant indeed.

The comment was made that deciding to attend a reunion can be quite traumatic, because it forces you to confront your past. We each still think of ourselves as we were when we left MIT: not as "nerdy" as some, yet more studious than others.

Yet, in attending reunions we've discovered that we have something in common, and many of us have a great deal in common: spouses, kids, mortgages, advanced degrees, professorships, or the ability to hire one another. Without exception, we're finding our classmates to be good, down-to-earth people who understand and pursue excellence.

Your friendly secretary would like to hear your thoughts about life 10 years after MIT. News has been scarce this month, so why not stop right now and drop me a card or letter telling about what you've been up to? Send your philosophic meanderings or just your news.—**Jim Bidigare**, Secretary, 659 Green St., Cambridge, MA 02139

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10th Reunion

Happy New Year, everybody. Don't forget, this is our tenth-reunion year. Hope to see you in Cambridge in June. I just read that the class of '78 had a record number of alumni at their tenth—now we don't want to be outclassed by those tuckies, do we? Go make those plane reservations NOW!

Not too much to report this month. My old friend **Dan Nathan** wrote recently with some exciting news. "My wife, Dori Bernstein, and I had a baby daughter, our first child, on July 15. Luisa Bess Nathan arrived just in time for Dori to miss having to carry her through the worst of the Washington, D.C., heat wave. Lou, as we call her (we also call her 'crazy face') is everything that you could ask for in a daughter, with a face that was beautiful from birth, eyes that cross at timely moments, and strong legs that allow her to climb up my chest in search of food. My former fellow Logarithms might be happy to know that I often sing her to bed with solo renditions of 'Baby Face' and 'Coney Island Baby.' We three are very happy, and to the extent that Dori and I ever had career ambitions, Lou has gurgled them out of our lives. On the career front, I am currently a branch chief in the Division of Enforcement of the Securities and Exchange Commission, trying to keep the streets safe for investors. I sometimes miss the frenzy of New York life, but am very happy with the quality of my life in Washington, especially the parking situation."

Joanne (Tobias) Berenberg married Barry Berenberg, an internist who practices in the Bronx. They live on Manhattan's Upper East Side, and Joanne commutes two days a week to New Jersey to continue her dental practice.



J. Vanwoerkom

Jack A. Vanwoerkom was recently appointed chief operating officer of First Winthrop Corp., a Boston-based real estate investment company. A Winthrop partner for three years, Jack was previously general counsel for the firm. Prior to joining Winthrop, he was a partner with the law firm of Hale and Dorr.

So that's all I have. Until next time.—**Jennifer Gordon**, Secretary, c/o Pennie & Edmonds, 1155 Avenue of the Americas, New York, NY 10036

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A mini-reunion dinner will be held at MIT's Faculty Club on November 4. While this column's deadline prevents me from reporting on the results until next column, we expect a good turnout from the area's 230 classmates (about one fourth of the class!). This get-together was organized by your class treasurer Diane Curtis.

I will soon be performing the role of Martha Jefferson in the musical *1776* in an Off-Off-Broadway production (that's New Yorkese for community theatre). Also appearing in the show is Charles Mobbs, '78, who shares a lab at Rockefeller University with my husband Robert Lustig, '76. Nothing else is new.—**Sharon Lowenheim**, Secretary, 500 E. 63rd St., Apt. 18B, New York, NY 10021

81

Hello everybody and a happy New Year. We are a bit slow in the news department this time around, so I'll have to come up with something myself to contribute.

The first piece of mail came from **Joan Horvath** who married Stephen Urwin in June. Joan is a member of the technical staff at the Jet Propulsion Laboratory in Pasadena, Calif. Steve is a member of the professional staff at Caltech in the astronomy department. The ceremony was held in a garden at Caltech and Kim Lewis, '82, was the maid of honor. Congratulations. . . . **Joe Molitoris** wrote to say that he spent the summer doing research work with the anti-armor group at Eglin Air Force Base on the sunny gulf coast of Florida. Joe reports that **Rich Valicenti** has passed his medical boards and now is busy with rotations at Hahnemann Medical School in Philadelphia. . . . **Edward Glassman** returned from a six-month assignment in Tokyo where he did robotics research at IBM Japan. Now he claims to be trying to discover if there is indeed life after sushi. Back in the states Edward is working at IBM Research in New York and skiing and traveling to warm places.

In addition to the mail, I received two press clipping compliments of the Alumni Association. The first classmate in print is **Steven Fetter** who is an assistant professor in the School of Public Affairs at the University of Maryland. Steve has published several articles on fission and fusion reactor safety, arms control and related topics. Most recently he completed a book titled *Toward a Comprehensive Test Ban*, which is sure to make the *New York Times* best seller list. Please write to Steve in College Park, Md., if you would like your copy autographed. The other press clipping concerns **Peter Sereda** who has been named assistant treasurer for Duchossois Industries in Illinois. Peter received a master's degree in finance and statistics from the University of Chicago.

Closer to home, my husband Ned and I are proud parents. Our son Eric Radlauer Lubell was born on September 3, 1988 at Beth Israel Hospital in Boston. He's a cute little boy and we are very happy he is ours. That's all for now. Please make it your New Year's resolution to write to your class secretary.—**Lynn Radlauer Lubell**, Secretary, 216 Beacon St., Boston, MA 02116

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Happy 1989! According to the local newspaper in Everett, Mass., **David Kieda** had a busy 1988. He married Lisa Goldstein (Wellesley '83) last August, received his Ph.D. in high energy astrophysics from the University of Pennsylvania in September and moved to Salt Lake City shortly thereafter to begin work as a post-doctoral research fellow at the University of Utah.

Other Ph.D. news: **Eddi Wooten** is working toward a Ph.D. in applied physics at the University of California at San Diego. . . . **Richard Soley** was still at the Tute when he wrote but was expecting to finish his Ph.D. in 1988 and looking forward to spending more time with his wife, Isabel Szabo, whom he married in 1983, and their first child, who was due in October. While in school Richard served as chairman and CEO of A.I. Architects, Inc., which is located across the street from MIT; after finishing he plans to spend time consulting and in entrepreneurial pursuits. Speaking of entrepreneurial pursuits, **Daniel**

Grunberg is starting a chain of tax preparation offices as a franchise of Jackson-Hewitt Tax Service. The offices will be fully computerized and take advantage of the IRS Electronic Filing systems in Boston, allowing people to get refunds in as little as one to three days. Daniel is also doing software and systems engineering consulting for Jackson-Hewitt and other firms. . . . **Tanya Sienko** is active in space development and has been publishing quite a few science and space articles. . . . **Steven Taylor** reports that he is now a civilian and plays ultimate in the Boston area corporate league for Tekscan (he doesn't say that he works there, however). Steven notes that he is still unpublished.

Philip Kauffman graduated from the veterinary school at the University of Pennsylvania last May and started work at a clinic in New Hampshire. He still rock climbs whenever and wherever possible, primarily with Steve Carroll, '84. . . . Another class veterinarian, **John Hollis**, is in Nairobi, Kenya, for a two-year stint with the United Nations' Food and Agricultural Organization. John will be doing epidemiological work, trying to eradicate a deadly cattle disease called "rinderpest," at least that's what East Coast correspondent **Linda Schaffir** could decipher from John's handwriting. Linda, by the way, took an exciting trip to Stockholm and Leningrad last fall.

Allison Casey reports that she is involved with the protection of public lands, particularly wilderness areas in Arizona, designated Wild and Scenic Rivers, and the Grand Canyon. She hikes and rafts extensively in the Southwest. . . . **Richard Cohen** writes that he plays in several bands in the Boston area, including the Hardtops. I've also heard that Rick recently left DEC to work for a company that makes electronic synthesizers. . . . I ran into **Aaron Rapoport** at a wedding recently and got an update on last month's report: this summer Aaron will be starting a fellowship in hematology at Strong Memorial Hospital in Rochester, N.Y.

Let's all make a New Year's resolution to write or call one of your many class secretaries with news about ourselves and our classmates. You can contact East Coast correspondent **Linda Schaffir** (18 Prospect Ave., Apt. B-2, Norwalk, CT 06850), West Coast correspondent **Michelle Gabriel** (656 S. Fair Oaks Ave., D-211, Sunnyvale, CA 94086) or me.—**Stephanie Pollack**, Secretary, 722 W. Roscoe St., #204, Chicago, IL 60657

83

Hello classmates! Here's this month's news.

Debora (Hills) Zukowski writes that she and husband Charles are doing well. He is an assistant professor at Columbia's School of Engineering, and she is an engineer at IBM's T.J. Watson Research Center. Their daughter, Claire Elizabeth, was born April 9, and is the reason that Debora missed the reunion. Well at least we know what their priorities are!

This has been the month of the press release as a source of news on classmates. We got word from Sasaki Associates that **Patricia Smith** has been promoted to senior associate. She also serves as director of Computer Services. . . . The navy reports that **John K. Roberts** recently participated in exercise Cobra Gold 88 while serving with Marine Medium Helicopter Squadron-268 in Tustin, Calif. Roberts has also participated in various air, land, and sea operations in Rayong Province, near Bangkok. . . . The *National Science Foundation News* reports that **Raymond E. Goldstein** has been selected as one of 20 people to receive an NSF postdoctoral fellowship in chemistry. Raymond double majored in chemistry and physics, and then went on to Cornell for his doctorate.

We also received notice from institute sources about several other classmates. **Marc Simmons** is involved in real estate, raising a show dog, playing music, and also photography, welding, carpentry, marksmanship, and acting. He is

currently customizing his camper for a three-month cross-country trip. During the trip he will put the finishing touches on his new book, *Interests That Have Nothing To Do With Each Other*. . . . **Kevin Scott Ring** is taking a sabbatical from construction management to become a ballroom dance teacher and performer. . . . **Lee Howard Marzke** is teaching powered-aircraft flight instruction at Phoenix East Aviation at the Lawrence, Mass., airport. He is also an adviser for Aviation Exploring Post 274, Manchester, NH.

Henry Hong-Yih Lin wrote that he was starting an orthopedic surgery residency at Washington University in St. Louis in July 1988. He just completed his general surgery internship. . . . **Lisa Ruth Granick** wrote that she started an MBA/MA program at the University of Pennsylvania. The MA program is in international studies, in which Lisa will specialize in Western Europe and the German language. . . . **Mathew O'Rourke Tobin** reports that he is running and cross-country skiing. . . . **Brad Householder** and his wife, Wendy, showed up at our class reunion. They were expecting their first child in October and were looking for a house. Brad works at Ceramics Process Systems here in the Boston area.

The following information comes from Noelle Merritt, '85: **Lisa Ambrogi** is still enjoying her work as a veterinarian. . . . **Ken Dumas** is working for United Airlines at Logan. . . . **Danny Kramer** graduated from Harvard Business School, but his whereabouts are unknown. . . . **Terry (Sutton) Sultan** is married and living in New Hampshire, where she runs for the DEC Women's Running Club. She recently placed tenth in the Manufacturer's Hanover Corporate Challenge road race. . . . **Steve Kosowski** is now in his second year at Harvard Business School.

Lastly, I regret to inform you of the death of **Dale Van Laningham** of Waterbury, Conn. Dale passed away January 12, 1986, at the Mayo Clinic in Rochester, Minn. He was married for a short time to Elizabeth Beliveau, '84.—**Jonathan Goldstein**, Secretary, 2 Soldiers Field Park, #201, Boston, MA 02163

84

5th Reunion

I just wanted to say thank you—some classmates actually wrote in to tell us what they are doing. As you know from past columns, we secretaries really appreciate the input. After all, not all of us are creative writers (especially me, as I know a lot of you are thinking right now). I'd also like to wish all of you a Happy New Year. I hope 1988 was a good year for you and that 1989 will be even better. Just one comment before I go on to the news—to give you an idea of how far in advance we have to write these columns, and consequently why so much of our news is old, the Olympics are in progress at this very moment. That's September for those of you who were out of town at that time. Anyway, to the news.

Sometimes I feel this is just a column to report marriages (no children yet?). For example, **Wayne Greene**, who graduated from Berkeley with a Ph.D. in chemical engineering in May and now works at HP Labs in Palo Alto as a process integration engineer, married Marcia Fox in June. They live in Campbell, Calif. . . . **Kathy Takayama** married Dr. Paul March in October, and she has just purchased her first condominium (wish I could say the same!). . . . **Shani-Sheryl Strothers** also got married in 1988 to John Thompson, '83, and is living in Bedford-Stuyvesant, Brooklyn. She owns a tie-dye shibori manufactory where cotton goods are processed and sold wholesale to designers and other stores. She received a degree in textile technology from FIT and seems very active in the community. She also wonders if anyone is interested in purchasing fabric! . . . **Mark Johnson** married Jennifer LaMonte and moved to Pottstown, Pa., where he started ALN Circuits. . . . **David Chiang** will marry Agnes Yeung in February in Menlo Park, Calif., where he is also working at Altera Corp. . . . Finally (but not

least) **Sho Fuji** is getting married in New Jersey this year—this information is secondhand, and I don't know his fiance's name.

On to other business. . . . **Tanya Segal** writes, "I just completed an M.B.A. in real estate and finance at Wharton. Have accepted a position with a firm in New York City that arranges pension-fund investments in commercial real estate and redevelops the properties. I will be working for the partner who handles development and redevelopment. (It will start in July, so some of the information I have provided is a little premature.) Also had an article (co-authored) published in the October 1987 issue of *National Resources Journal*. . . . **Anne Moroney** has been "happily living with Steven Ladd since 1982. Seriously studying objectivism, the philosophy of Ayn Rand, since 1985." . . . **Jonathan Miller** has been "projecting movies for the AV department since before graduation, on a part-time basis. This activity grew out of my experiences as a member of LSC. I bought and sold an income property in Boston and now work part-time as a real estate salesperson." . . . **Stephen Korthals-Altes** writes, "My wife and I got a chance to model for a catalogue this spring" (I wonder which catalogue?).

Beverly Ferris Williams is involved in Ruggles Baptist Church in Boston and investigating the start of a neighborhood church in the Mission Hill area, where she and her husband live. . . . **Suresh Subramanian** has "just received my Ph.D. in computer science and engineering from the University of Michigan, and am now working for Bellcore at their Software Systems Center in Piscataway, N.J." . . . **Joan Abrams** writes that she has now done "three of the big four 'grown up' things: got married, bought a car, bought a home. The last of the four is biggest: family. That's still a few years in the future, if physiology cooperates!" (Does that mean I'm still a kid, since the only thing I've done is buy a car?)

Paul Hsieh is now at the University of Michigan medical school planning to receive his M.D. in June 1989. He will probably specialize in radiology. He also "spent a fantastic year at the NIH doing NMR research with Dr. Robert Balaban, resulting in two papers and one patent application." . . . **Christopher Grayce** has "constructed a perfect philosophy which allows for maximum personal reward while ensuring social stability and consistency. Unfortunately, it does not appear to be adaptable to human beings."

And two final notes: **Andrew Chien** was working for HP Labs for the summer, but is now back in grad school at MIT to finish his Ph.D. in 3 years. And **Andy Litman** has just started on his advanced degree at the University of Washington, where he writes that "the weather is great, come visit anytime!" . . . That's all for now folks—more news coming in the future. Keep those letters, cards, and updates coming.—**Mona Wan**, Acting Secretary, 12231 Viewoak Dr., Saratoga, CA 95070

85

There are now three more start-ups founded by class of '85 members! **Michael Andrew Burns** founded Nationwide Computers last October. He has one partner and 20-25 employees. They are in the process of opening three more offices in 1988. They have also received a merger offer from a large computer manufacturer, so their name might change soon. Michael spends his weekends on the company boat with Tom Fantacane, '84, and Lauren Singer, '86, in Biscayne Bay. He lives with his brother, two dogs, a cat and 20 fruit trees on the river in Ft. Lauderdale.

Bryan Finkel is the co-founder of Spectral Innovations in Sunnyvale, Calif. They make real-time signal processing workstations for the MacII. He writes that **Rob Scharfman** is heading toward a residency in ophthalmology. **Andy Furman** is working toward his first million trading commodities on the NYSE and **Dave Weissburg** is now at Polaroid.

Michael How, '84, and **Atul Jain** founded a small consulting practice last September. The firm's name is (for many reasons) Tech Hackers Inc. (the corporate colors are red and grey). Their practice has gotten off to a good start. They have focused on building real-time analytic trading systems in the areas of fixed income securities, options, and portfolio risk management. Their latest client is Citicorp Investment Bank. **Niels Lauritzen**, '84, and **Roderick Mason**, '86, have joined them. Niels is helping to expand their consulting practice and Rod is marketing an innovative software package for financial professionals with PCs. They are keeping their fingers crossed for a stable stream of cash flow. So far it has been a fun, but often nerve-racking ride.

Atul has had a few opportunities to travel abroad over the last three years. Right after graduation he spent a month driving from Boston to Seattle by way of Guadalajara, Mexico. Since then he has made it to Japan, Hong Kong, Thailand, India and Peru. He is discovering that he has a deep passion for travel. And he's not alone, **John Frishkopf** and **Niels Lauritzen** are equally possessed.

On July 23rd **Clifford Eskey** and **Felix Goldenberg** were married in Heinz Chapel at the University of Pittsburgh. Members of the MIT varsity rifle team and the coach attended the wedding. Clifford and Felix are nationally known for target shooting. They honeymooned in Canada and are now living in the Greenfield section of Pittsburgh.

Elizabeth Barnes was married in August and is also living in Pittsburgh. She is working for a consulting or major accounting firm there. **Chiquita White**, **Lisa Ramsey** and **Patrice Hornsby** were all attendants in the wedding.

Chris Getschow and **Karin Duston Getschow**, '86, are the proud parents of **Carolyn Ann**, born March 30, 1988. Karin is almost a First Lieutenant stationed at Wright-Patterson AFB, Ohio. She is working on biomechanical protection and aircraft escape systems. Chris is a systems engineer at SofTech in Fairborn, Ohio.

Paul Gabuzda is enrolled in the MBA program at University of California-Los Angeles. He thinks it's unfortunate that he had to move to Westwood since he loved living in Laguna Beach for the past three years. **David Mondelevitch** is also a student. He is attending University of Southern California's School of Cinema in the master of fine arts program. **Erik Devereaux** completed his comprehensive examinations last February. He expected to be a candidate for a Ph.D. in political science at the Department of Government, University of Texas at Austin in June (I don't know if he is now). He was elected chair of the department's graduate student organization for the academic year 1988-1989. In the summer of 1987 he spent six weeks traveling in Europe. He planned to spend two weeks last summer visiting his home state of New Mexico.

Justin Ryan was promoted to a U.S. Navy lieutenant while stationed at Chase Field, Tex. **Richard Weaver** says that after going through MIT, the real world is easy! He has been playing tennis and working out. It also seems that he can't work without a computer. He hopes everyone is enjoying the "real" world as much as he is! **Will Sauer** has been a metallurgist with the U.S. Bureau of Mines for over a year now. He is involved with establishing a "wellness committee." Outside of work, his hobby is triathlons. **Larry Poletti** is considering applying to medical school. He is volunteering some time at a local hospice; and also is trying to improve his pool game, and fitting in a few games of racquetball here and there.

Most of **Mary Petrofsky**'s free time is spent outdoors. She works as a sea kayak instructor any weekend that she doesn't have other plans. She also spends her weekends downhill and cross country skiing, white water rafting, river kayaking, backpacking, cycling, hiking and kayak surfing. During the week she plays volleyball, swims and kayaks. But wait there's more! She is

involved in two volunteer organizations, Outdoors Unlimited and Environmental Traveling Companions. The first is an "adventure cooperative" that runs many inexpensive clinics and trips (all our instructors are volunteers). The other is a group that runs outdoor activities (mainly sea kayaking, whitewater rafting and crosscountry skiing) for "disadvantaged" groups, such as quadriplegics and paraplegics, deaf people, blind people, cancer patients, AIDS patients, inner city youth, drug rehab groups and so on.

Charles Grimes says that going from MIT to an arts-based career has sparked some wonderfully unbelieveable, astounded responses. He is always proud to tell people how active MIT is in the arts and how qualified its liberal arts program is. He feels that one learns respect for academia as a whole from being at MIT. And, the school and faculty are to be commended for providing its students with the opportunity to explore interests and programs thought not to be associated with the concerns of the stereotypical MIT student.

Andrew Bennett is buying a house in Cambridge and assisted MTG in their summer production.

Alan Foonberg and his girlfriend are buying a house outside of Manhattan Beach, Calif. He just celebrated his fifth anniversary of his hire date at The Aerospace Corp. in El Segundo. His job has taken him to Washington, D.C., Boston, Hawaii, and to Germany twice. While he was in Germany he contacted **Inge Gedo** Applewhite. Inge is stationed there with the U.S. Air Force. Alan is also still playing softball three-four times a week.

Michael Cassidy was the chief strategist for the GM Sunracer which won the solar powered car race across Australia in November 1987. He also has played the piano in the Los Angeles Jazz Ensemble and has recorded about 10 original songs, including "Molecular Diffusion" (anti-smoking song) and "I Don't Want to Be Your Number 34." He has traveled all through Europe, USSR, China, Japan, Australia, Israel, and Egypt. He was planning a trip to northern China for the fall of 1988. When he's home in Los Angeles he lives on the beach and bikes to work.

And, in late breaking news **Tony Masterson** and **Terri Munson** will be married July 18th in Cupertino, Calif. Hopefully, their manager will give them some time off for a honeymoon!—**Stephanie Winner**, Secretary, 1026 Live Oak Dr., Santa Clara, CA 95051

86

Thanks for all the letters. All of my complaining really paid off. Lt. (j.g.) **Chris Medina** wrote in from the U.S.S. *Merrill* where he is serving as the Combat Information Center officer. He recently returned from a six-month deployment in the Persian Gulf. **James Person** is also aboard as the damage control assistant. They got to see some combat action while in the Gulf but also got to see some exotic ports: Island of Seychelles, Bahrain, Philippines, Hong Kong, Korea and Seattle. Chris lives in San Diego and is engaged to Karla Kramer. They plan to get married in the spring of 1989.

Chuck Stern wrote from Watertown, Mass. He graduated and was commissioned in February 1987 but decided to go into the U.S. Air National Guard. Accepting a position as the communications operations officer earned him 30 weeks at Keesler AFB, Miss., for training. After finding out there was nothing to do in Biloxi, Chuck returned to Boston and started working for Prime Computer in Framingham. Chuck rooms with his pledge brother, **Jim Reisert**, who works for DEC-Littleton and **Dave Krantz**, '85. **Allan Armstrong** works for Hewlett-Packard in Santa Rosa and **Steve McInall** got his master's from MIT in nuclear engineering. **Sergio Ajwia** is working on his Ph.D. at MIT in course 3. **David Weisenberg** is at the Jet Propulsion Lab in Pasadena, Calif., designing the guidance system for Galileo. **Scott Miller** is working for Harris in Los Angeles,

where he recently became engaged.

Patricia Kennedy got married to Philip Hamman, '88, and they are living in their new condo in Kendall Square. **Robert Lenoil** is keeping busy, both at work and at play. He sings in a barbershop chorus and also performs in a comedy improvisation group called ComedySports. He is also taking hang gliding lessons. First Lieutenant **William Vincent** was promoted to his current rank and is serving with the 1st Marine Division at Camp Pendleton, Calif. **Linda Robeck** completed the one-year master's program in aero/astro at Stanford. She is working at JPL also working on the Galileo guidance system. Linda is planning to climb her first 14,000-ft. mountain in anticipation of climbing Mt. Whitney, the tallest peak in the contiguous 48 states.

John Port finished his second year of medical school at the University of Illinois at Chicago. Soon he'll start his Ph.D. work in neuroscience. One day he hopes to combine his medical, computer science and neuroscience degrees into a useful career in artificial intelligence. **Edward Kriegsman** is studying law in pursuit of a J.D. degree. Upon graduation from law school, he intends to practice patent law in the greater Boston area. **Ratmdeep Damle** works for the Grumman Corp. and is pursuing a master's at Columbia University in electrical engineering. He is in a master's fellowship program which allows him to get his master's while having rotating work assignments within Grumman. **Michael Bates** attended Alan Yuch's wedding in Waterville, Maine. He also visited five major league ballparks in six days, stopping in to see **Melissa Ayuyao** and **Karla Johnson**. He is still working at Burteke, a flight simulator company in Tulsa.

At a party held recently here in Los Angeles, a small reunion was held. **Karl Tucker** and **Don Davidoff** came in from Norton AFB and **Doug Norton** also showed up. Doug works for Hughes here in El Segundo. Karl mentioned that Chris Dorn, '87, works at Norton as an aircraft maintenance officer and Bruce Lundy, '88, would be arriving there for duty. **Karen Wohl** wrote in from one of her Harvard Business School classes (those classes must be demanding). Karen says that Biz School is a lot of work but after the Booze Cruise she described, I'd have to guess she's getting her share of play, too. Karen and **Ellen Epstein** found time to tour Thailand and China at the end of the summer. Ellen is working at Merrill Lynch in New York City.

I was in Alabama recently and ran into **John Tantillo**. He said that **Andy Sparks** was engaged. Both of them work at Wright-Patterson AFB in Dayton, Ohio. Keep up the good work.—**Mary E. Cox**, Secretary, SD/CLFP, P.O. Box 92960, Los Angeles AFB, CA 90009-2960

87

Let's Go Beavers! Special congratulations to the MIT Division Three Football Team! The publicity was amazing. I've heard that our new status has been announced at football games all the way from Syracuse University to the University of Arizona.

But I suppose you want to know more about the people in our class. My first exciting information is a wedding. **George Cole** and **Linda Macciari** (Wellesley College '87) were married on May 22. George is employed as a civil engineer by Simpson, Gumpertz & Heger, consulting engineers in Arlington, Mass. His wife, Linda, is an editor with Porter Sargent Publishers of Boston. Since their honeymoon trip to Bermuda, they've been living in Wellesley. (I'm sure there have been other weddings, please write to me so I can let everyone know.)

Mike Foley was especially helpful with information this month on some of his friends from DEKE. Mike is presently working at Draper Labs in Cambridge. He spent the summer with **Ted Devlin** touring Europe in a VolksWagon microbus. Ted is living in the bus in a parking lot in Lon-

don near the Royal College of Art, where he is completing his master's in industrial design.

Steven Hoenig is in New York City in his second year of medical school at Columbia. **David Luneau** is working at Summa Four and enjoying life in scenic New Hampshire, "only miles from the Anheuser Busch Factory." **Jon Kane** is in his second year at Tufts, working towards his master's in electrical engineering. **Ed DeVoe** is completing a graduate degree in nutritional studies. **Duncan McCallum**, **Burl Amsbury**, and **Rick Sapienza** are all working at Draper Labs.

Important Announcement: Fine Line has its first album out and it's sure to be a success! In the write-up in Boston's *Beat* magazine, the reviewer claimed that the album had the best song by a local band of the year.

Mike Decker is back from New York and working with computer software systems in Harvard Square. **Jeff Klohr** has moved back to St. Louis to start his career in mechanical engineering. **Dave Napoli** spent part of his summer in Europe and is now in his second year at Down State Medical School.

That's all I've got for now. I'm going to need some more help from you to make this column better in the future. Don't forget to send those letters! Thanks, and have a great New Year!—**Stephanie Levin**, Secretary, 41 Prentiss St., Cambridge, MA 02140, (617) 547-6673

88

Greetings from the Big Apple! I've just finished my third week here at New York University Medical School, and for those of you who knew me during our first few years at MIT, the "old Grace" has returned! I can't believe I'm writing our first class notes column. I can't get used to being an alumna. How are all of you adjusting to life without MIT? Drop me a line and tell me all about it. Your classmates want to hear from you. Many of you out there are probably just getting settled into your new jobs or graduate schools. Be sure to notify the Alumni Association about your new addresses.

Julian Marci is currently a procurement manufacturing engineer for IBM in Charlotte, N.C. He spent his summer traversing Europe—"France was great, Italy was ok, and Switzerland is beautiful!" However, much to his dismay, Charlotte is hot and humid. . . . **Marc Light** spent 1988 in Switzerland working in his field (cognitive science/computer science). In 1989 he will enter graduate school at the University of Rochester. . . . **David Schmidt**, **Mike Turek**, **Stuart Olmsted**, **Bufie Duran**, and **Conrad Winkler** are all stationed at the U.S. Navy's Nuclear Power School in Orlando, Fla., for six months (starting August 1988). In little more than a year they will complete all their nuclear training and will then report to their first submarines.

Linnea Avallone, formerly an Epsilon Theta, was kind enough to write me about the plans of everyone in her pledge class. Linnea is in a Ph.D. program in physical chemistry at Harvard. **Andrew Chang**, a fellow biology major, is at medical school at Johns Hopkins University in Baltimore. **Dionne Tobey** is continuing at MIT in a master's program in civil engineering in the Environmental Division. **Mary Penniston** is working at Hewlett-Packard in Fort Collins, Colo., and married Mike Vermeulen ('85) last May 28 (the day after graduation!). Congratulations to both of you. **Larry Label** is involved in a master's program in transportation at U.C. Berkeley.

Two class of '88 members won't be graduating until 1989: **Karen Kirmse** is working at COMSAT in Maryland for nine months to finish her master's, and **Tina Bartschat** is hoping to finish a bachelor's in chemistry and master's in civil environmental engineering. . . . **Anthony Kassir** formerly class of '89, graduated a year early and is home for a year in San Diego, where he will either work in a biology lab, teach high school, or serve as a trainer at Sea World. Next fall he will

enter a medical school "to be determined, with a good chance of becoming a neurosurgeon, unless I first become a world-famous musician or get eaten by a whale."

David Bruno spent last summer working at the IBM Almaden Research Center in San Jose, Calif. He is now at grad school at Cornell University in the field of materials science and engineering. . . . **Michael Mendolia** is also doing graduate study in materials science, but is at the University of Pennsylvania. . . . **Michele Sarin** is studying statistics in a master's program within the Wharton School at U. Penn. . . . **Joe Harrington** is going for his Ph.D. in planetary science at MIT. . . . **Paul Kwei** is attending graduate school at Berkeley. He is studying heat transfer and conducting thermodynamic research in the department of mechanical engineering.

Mike(y) Teng sent me a list as to the whereabouts of the '88 Kappa Sigma pledge class. Mike is currently doing graduate in biology at the University of Chicago. **Young Shin** is completing a degree in Course XV and living in Boston. **Paul Acosta** is completing a Course VIII degree. **Pat Cobler** is working at Honeywell and living in Boston. **Bob Bielinski** is working for Shearson-Lehman Hutton in Manhattan. (I have yet to run into you at the Seaport!) **Emilio Cacciavillani** and **Dante Togliatti** are both attending grad school at the University of Hawaii, in chemistry and physics, respectively. **Andrew McAfee** is studying in the Leaders in Manufacturing Program at MIT for a joint S.M., M.B.A. **Mark Meixner** is completing a Course XVI degree at MIT. **Jim Pierce** is attending Course II grad school at MIT. **Gary Frantz** is working and living in Atlanta. The activities of **Daryl Habberstad** and **Rob Aruta** are pretty much a mystery, so please write!

Now for some medical school students. **Christine McIntyre** is attending the University of Michigan. **Mike Couris** is at Georgetown University. **Jane Ko** is at the University of Chicago (I found this out from Kewchang Lee). **Joe Woo** is at U. Penn, **Steve Stein**, at N.Y.U., **Karen Wu**, at Columbia, **Ellen Maker** at Mt. Sinai, and **George Huang** at Harvard Medical School.

Scott Lichtman was selected a Tau Beta Pi laureate for his many contributions to student life as an undergraduate. Vice-president of Tau Beta Pi's Massachusetts Beta Chapter, member of Eta Kappa Nu, and president of his Pugwash chapter, Scott was selected a Marshall scholar and is studying international affairs at the London School of Economics.

The news on the "Wall Street" crowd (according to **Ziad Ayoub**) is as follows. Ziad, **Lynn Hazen**, and **Ed Forzani** are all working for Merrill Lynch in Municipal Markets. Lynn is living in an apartment with **Tracy Wood**, who is working for a New York consulting firm. **Andrea Wong** is working for First Boston, **Earl Yen** is working for Bear Sterns in Boston, and **Roberto Solin** is working for Bankers Trust.

Chris Saito and **Dave Silldorff** are attending Navy flight school in Pensacola, Fla. . . . **Mike Fox** is in grad school (Aero/Astro) at the University of Washington (state, that is). . . . **Mike Frye** is working for Hewlett-Packard in California.

Lisa Martin is working extremely long hours at Dunn and Bradstreet in Port Washington, N.Y. She writes about many of our classmates. **Craig Jungwirth** is working for Imagination Technology in Florida doing theme park design. **Stacy Arbeiter** is training as an analyst at Prudential Bache. **Tony Curtis** spent most of the summer in Europe, where he ran into a number of Bakers, including **Mike Adelberg** and **Don Woodring**. Tony is now attending grad school at Princeton. **Mark Hansen** is attending grad school at the University of Michigan after working in D.C. last summer. **Kelly O'Neill** is living with **Wendy Haller** and **Sarah Adams** in Boston. Kelly is finishing up EIP at Lincoln Labs.

Well, that's all folks! Thanks for the letters and phone calls! Lets keep them coming.—**Grace Ma**, Secretary, 435 E. 30th St., New York, NY 10016, (212) 545-7764

Deceased

The following deaths have been reported to the Alumni Association since the *Review's* last deadline:

William H. Bradshaw, '07; June 1, 1987; Block Island, R.I.
Hampar T. Gazarian, '14; August 29, 1988; Ormond Beach, Fla.
Kenneth K. Boynton, '15; June 28, 1987; Asheville, N.C.
Elbridge R. Devine, '16; August 6, 1988; Pelham, N.Y.
Arnold B. Staubach, '19; September 24, 1988; Houston, Tex.
Donald G. Morse, '21; September 24, 1988; Wellesley Hills, Mass.
Ralph H. Price, '21; June 29, 1988; Austin, Tex.
Charles H. Burnham, '22; 1982; Exeter, N.H.
F. Reed Dallye, '22; June 25, 1987; Newport Beach, Calif.
C(harles) George Dandrow, '22; August 9, 1988; Jacksonville, Fla.
George S. Holderness, '22; September 10, 1988; Bronxville, N.Y.
Kohei Kagami, '22; May 1988; Tokyo, Japan.
Charles Ayres Williams, '22; September 7, 1988; Deerfield, N.H.
Bernard F. Flynn, '23; August 15, 1988; Los Angeles, Calif.
Mrs. Robert Hendrie, '23; July 1982; Braintree, Mass.
Ralph H. Price, '23; June 29, 1988; Austin, Tex.
Pierre F. de Reynier, '23; July 22, 1988; Mesa, Ariz.
Richard D. Jackson, '24; July 31, 1988; Tampa, Fla.
Everett R. Leroy, '24; June 4, 1988; New York, N.Y.
Chester H. Hosmer, '25; June 8, 1988; Modesto, Calif.
Dean Morrough P. O'Brien, '25; July 28, 1988; Cuernavaca, Mexico.
Rexford A. Bristol, '26; September 13, 1988; Foxboro, Mass.
Gilbert C. Delvaille, '26; September 7, 1988; Riverside, Calif.
Carl N. Pratt, '26; August 29, 1988.
George B. Torrens, '26; November 2, 1987; Shrewsbury, Mass.
Morton P. Woodason, '26; September 17, 1988; Sharon, Mass.
Hermon T. Barker, '27; September 9, 1988; East Walpole, Mass.
Herbert G. Johnson, '27; April 2, 1988; West Chester, Penn.
Dorio G. Lefourneau, '27; August 25, 1988; Plainfield, N.J.
Chungsoo Oh, '27; August 5, 1988; Seoul, Korea.
Charles A. Sanborn, '27; September 17, 1988; Kittery, Maine.
Walter G. Walker, Sr., '27; August 23, 1988; Newport News, Va.
Robert W. Carder, '28; August 21, 1988; Westbrook, Conn.
Donald T. Hall, '28; July 23, 1988; Honolulu, Hawaii.
Mrs. Marshall S. David, '29; August 19, 1988; West Dennis, Mass.
Charles Frank, Jr., '29; March 9, 1988; Waltham, Mass.
Mrs. G. Ridgley McDaniel, '29; August 4, 1988; Painesville, Ohio.
Charles W. Sampson, '29; September 17, 1988; Rochester, N.Y.
George A. C. Holt, '30; May 12, 1988; Hoosick Falls, N.Y.

George Kaplan, '30; 1988; Newton Highlands, Mass.
Mendall P. Thomas, '30; August 29, 1988; Hartford, Conn.
Albert E. Wager, '30; August 4, 1988; Albany, N.Y.
Franklin H. Dewey, '31; October 18, 1986; Rochester, N.Y.
Joe L. Franklin, Jr., '31; August 25, 1982; Houston, Tex.
Howard F. Jenkins, '31; October 3, 1988.
Harry D. Kamy, '31; August 29, 1988; Indian Atlantic, Fla.
Gardner Cox, '32; January 14, 1988; Cambridge, Mass.
Edmund B. Fritz, '32; August 12, 1988; New Providence, N.J.
Richard Huesener, '32; September 30, 1988; Pittsburgh, Penn.
Elmer H. Stotz, '32; November 22, 1987; Rochester, N.Y.
F. Lawton Barrows, '33; May 14, 1988; Middleboro, Mass.
Richard R. Chase, '33; November 13, 1986; West Newbury, Mass.
Vincent C. Frisby, '33; April 1987; Boise, Idaho.
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Ralph P. Johnson, '36; February 11, 1988; Manhattan Beach, Calif.
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Benjamin F. Lippold, '36; June 20, 1988; Fresno, Calif.
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Enrique R. Lima, '48; July 19, 1985; San Salvador, El Salvador.
Valentin Nasipak, '48; December 24, 1987; Manlius, N.Y.
Reginald B. Stoops, '48; September 14, 1988; Newport, R.I.
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Joseph K. Dillard, Jr., '50; February 13, 1988; Pittsburgh, Penn.
William C. Morton III, '50; August 28, 1988; Wellesley Hills, Mass.
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William C. Griffiths, Jr., '51; July 26, 1988; Pottstown, Penn.
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Theodore J. Gerken, '54; March 1987; Trexertown, Penn.
William A. Steyert, Jr., '54; May 2, 1988; Center Valley, Penn.
Bernard J. Regenauer, '56; August 27, 1988; Sudbury, Mass.
Alvin E. Fein, '58; May 31, 1988; Baltimore, Md.
Barry A. Mendoza, '58; July 5, 1986; La Mesa, Calif.
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Lawrence E. Laben, '59; September 17, 1988; Stamford, Conn.
Samuel A. Latt, '60; August 28, 1988; Newton Highlands, Mass.
James K. Okazaki, '60; July 1988; Seal Beach, Calif.
Hotace H. Squire, '62; December 26, 1987; Burlington, Vt.
A. Jerry Luebbers, '64; August 12, 1988; Chicago, Ill.
Richard S. Moore, '64; February 13, 1988; San Diego, Calif.
Gordon P. Nelson, '64; September 18, 1988; McLean, Va.
J. A. Silva-Michelena, '68; August 12, 1986; Caracas, Venezuela.
Paul C. Zimmermann, '70; April 24, 1988; San Francisco, Calif.
Christophe J. Riboud, '78; August 1988; Paris, France.
Hsiang Yun Chen, '87; April 2, 1988; Taiwan, China.
Clifford A. Wilburn, '90; July 20, 1988; Birmingham, Ala.

The Quickest Way to Smother the Mate

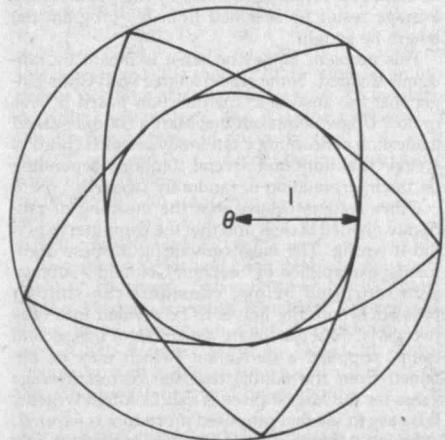
This being the first issue of another year, we again offer a "yearly problem" in which you are to express small integers in terms of the digits of the new year (1, 9, 8, and 9) and the arithmetic operators. The problem is formally stated in the "Problems" section, and the solution to the 1988 yearly problem is in the "Solutions" section.

Problems

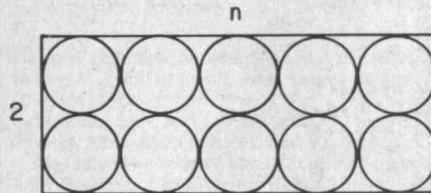
Y1989. Form as many as possible of the integers from 1 to 100 using the digits 1, 9, 8, and 9 exactly once each and the operators $+$, $-$, \times (multiplication), $/$ (division), and exponentiation. We desire solutions containing the minimum number of operators; and, among solutions having a given number of operators, those using the digits in the order 1, 9, 8, and 9 are preferred. Parentheses may be used for grouping; they do not count as operators. A leading minus sign does count as an operator.

JAN 1. Robert Bart wants to know the shortest chess game that ends in a true smothered mate, i.e., only the square the king is on is under attack, all the adjacent squares are blocked by "friendly" forces.

JAN 2. A non-Satanic pentagram (see diagram) is formed by intersecting five circular arcs evenly spaced around a circle. These arcs are tangent to a radius r circle concentric to the first and having half its area. Ken Rosato wants to know the radius of the arcs.



JAN 3. As illustrated below, it is easy to put $2n$ unit diameter circles inside a $2 \times n$ rectangle. Nob Yoshigahara and J. Akiyama want to know the smallest value of n for which you can fit $2n + 1$ circles?



JAN 4. John Rule is interested in perfect squares that when written (in base 10) use all ten digits once each. What is the smallest such number? What is the largest?

Speed Department

SD 1. Robert Dorich wants to know what the following numbers represent: 1345 and 11DE784A.

SD 2. Walter Cluett needs to extend the sequence 1427256.

Solutions

Y1988. The problem was the same as Y1989, above, except that the digits to be used were 1, 9, 8, and 8.

The following solution is from John Drumheller. The double eights make the problem harder (and the double nines that we will soon encounter are also troublesome). Indeed, this difficulty will remain until 2013.

1 1^{988}
 2 $1 + (9 \cdot 8)^8$
 3 $91 \cdot 88$
 4 $(9 / 18) * 8$
 5 -
 6 $8 - (18 / 9)$
 7 $8 - 1^{98}$
 8 $89 \cdot 81$
 9 $1^{98} + 8$
 10 $(18 / 9) + 8$
 11 $88 / (9 - 1)$
 12 -



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13 -	87 88 - 1 ⁹	98 1 + 9 + 88
14 98 / (8 - 1)	88 (19 - 8) * 8	99 1 ⁸ + 98
15 (8 + 8) - 1 ⁹	89 1 ⁹ + 88	100 -
16 (18 * 8) / 9	90 (1 * 98) - 8	
17 98 - 81	91 1 + 98 - 8	
18 19 - (8 / 8)	92 (8 / 8) + 91	
19 19 + 8 - 8	93 -	
20 19 + (8 / 8)	94 -	
21 -	95 -	
22 -	96 88 - 1 + 9	
23 -	97 (1 * 9) + 88	
24 9 + 8 + 8 - 1		
25 (1 * 9) + 8 + 8		
26 1 + 9 + 8 + 8		
27 91 - (8 * 8)		
28 -		
29 -		
30 -		
31 -		
32 -		
33 -		
34 -		
35 19 + 8 + 8		
36 -		
37 -		
38 -		
39 -		
40 -		
41 -		
42 -		
43 -		
44 -		
45 (8 * 8) - 19		
46 -		
47 (8 * (8 - 1)) - 9		
48 -		
49 -		
50 -		
51 -		
52 -		
53 -		
54 (9 * 8) - 18		
55 ((8 - 1) * 9) - 8		
56 1 - 9 + (8 * 8)		
57 -		
58 -		
59 -		
60 -		
61 -		
62 -		
63 (9 * 8) - 8 - 1		
64 81 - 9 + 8		
65 (1 + (9 * 8)) - 8		
66 -		
67 -		
68 -		
69 88 - 19		
70 -		
71 89 - 18		
72 (81 / 9) * 8		
73 (1 * 9) + (8 * 8)		
74 1 + 9 + (8 * 8)		
75 91 - 8 + 8		
76 -		
77 -		
78 88 - 1 + 9		
79 (88 * 1) - 9		
80 98 - 18		
81 (9 - 8) * 81		
82 81 + 9 - 8		
83 19 + (8 * 8)		
84 -		
85 -		
86 -		

Also solved by Greg Spradlin, Harry Zaremba, Avi Ornstein, Steven Feldman, and Allen Tracht.

A/S 1. David Evans has placed white knights on a1, b1, and c1 and black knights on a4, b4, and c4. He wants you to find the minimum number of moves needed to interchange the positions of the knights disregarding possible captures. Only the first four ranks and the first three files are to be used.

The answer appears to depend on whether the movement of white and black knights must alternate. This was the proposer's intent (at least his solution has this property) and it seems right to me, since otherwise why have the knights colored at all? Requiring alternation, John Chandler found a solution with each color moving 9 times, or 18 total moves.

1. c1-a2 c4-a3	6. a1-c2 a4-c3
2. a2-c3 a3-c2	7. c2-b4 c3-b1
3. b1-a3 b4-a2	8. a2-c3 a3-c2
4. a3-c4 a2-c1	9. c3-a4 c2-a1
5. c3-a2 c2-a3	

Richard Hess submitted the following 16 (total) move solution and reports that Reiter proved this to be best possible (*Journal of Recreational Mathematics* 16(1), p. 7, 1983-84).

1. a4-c3 c3-a2	5. a3-c4 b4-c2
2. b1-c3 c3-a4	6. c2-a1 a2-c3
3. c4-a3 a3-b1	7. c1-a2 a2-b4
4. a1-c2 c2-a3	8. c3-a2 a2-c1

Also solved by Chris Unger, Jonathan Aronson, Matthew Fountain, Bill Habeck, and the proposer.

A/S 2. Matthew Fountain reports that a computer expert wanted to find the average length obtained for the largest part of a line of unit length when the line is randomly divided into four parts. The expert wrote a program that summed four random numbers between zero and one and divided the largest of these four random numbers by their sum. Is the average result he obtained from his program the length he sought?

This problem hinges on what is meant by randomly divided. Some readers agree with Chris Unger that the answer to the question posed is "yes or no." Unger points out that Martin Gardner asked a question concerning a randomly selected chord of a circle that admitted several solutions depending on the interpretation of randomly selected.

Other readers believe that the meaning of randomly divided is clear and that the computer expert did it wrong. The most convincing of these arguments, exemplified by Stephen Goldfeld's submission reprinted below, considers the simpler problem where the line is to be divided into only two parts. Tom Harriman, a member of this second camp, supplied a derivation (which may be obtained from the editor) that the correct average value for the largest piece is .52. Goldfeld writes: It is easy to see that proposed procedure is *incorrect*, although it is rather messy to calculate analytically the size of the error. The source of the problem can be seen most simply if we restrict attention to the

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case of two random intervals. The proper answer is the expected value of the max of $(r, 1-r)$ where r is uniformly distributed on $(0, 1)$. This problem has answer $3/4$ —loosely speaking, half the time the variable r would be $\geq 1/2$ and have $3/4$ as a mean, while the other half of the time $(1-r)$ will have $3/4$ as a mean.

The proposed procedure generates, in our simplified setting, two uniform random variables, r_1 and r_2 , and simulates the expected value of $\max[r_1/(r_1 + r_2), r_2/(r_1 + r_2)]$. This yields a different answer, since $r_1/(r_1 + r_2)$ is no longer uniformly distributed on $(0, 1)$. Indeed, it is more likely that this ratio will be in the neighborhood of $1/2$ than it will be in the tails. As a consequence, the maximum will be less than the proper answer, $3/4$, since the maximum calculated improperly will be closer to $1/2$ more often than it should be. In the case of two intervals, the improper method yields an answer of about .693.

Also solved by Richard Hess, Matthew Fountain, Steve Feldman, Meredith Warshaw, Charles Whiting, Bill Habeck, and John Chandler.

A/S 3. Scott Berkenblit poses a challenge he saw in a Russian book of math problems. Find the exact value of the product $\tan(80) \tan(40) \tan(20)$, where all angles are expressed in degrees.

The following solution is from Harry Zaremba: The exact value of the product of the tangents is $\sqrt{3}$. In proving this, it is noted that from the tangent of the sum of two angles,

$$\tan(40 + 20) = \frac{\tan(40) + \tan(20)}{1 - \tan(40) \tan(20)} = \sqrt{3}$$

which yields,

$$\tan(40) = \frac{\sqrt{3} - \tan(20)}{1 + \sqrt{3} \tan(20)}$$

Also, from the trigonometric identity,

$$\tan(40) = \frac{2\tan(20)}{1 - \tan^2(20)}$$

Equating the expressions for $\tan(40)$ and simplifying,

$$\tan^3(20) - 3\sqrt{3} \tan^2(20) - 3 \tan(20) + \sqrt{3} = 0.$$

The equation above indicates that $\tan(20)$ is a real root of the cubic polynomial,

$$x^3 + Px^2 + Qx + R = 0$$

in which $P = -3\sqrt{3}$, $Q = -3$, and $R = +\sqrt{3}$.

The solution of the cubic results in three real roots which are,

$$x_1 = 4 \cos(10) + \sqrt{3} = \tan(80)$$

$$x_2 = 4 \cos(130) + \sqrt{3} = \tan(-40)$$

$$x_3 = 4 \cos(250) + \sqrt{3} = \tan(20)$$

It is recalled that the product of the roots on an n th degree polynomial is equal to $(-1)^n A_n A_{n0}$, in which A_n is the constant term, and A_{n0} is the coefficient of the n th degree term. In the cubic, $n = 3$, $A_n = R = \sqrt{3}$, and $A_{n0} = 1$. Hence, the product of the roots of the cubic is,

$$\tan(80) \cdot \tan(-40) \cdot \tan(20) = (-1)^3 \cdot \sqrt{3}$$

or,

$$\tan(80) \cdot \tan(40) \cdot \tan(20) = \sqrt{3}$$

Also solved by Richard Hess, Matthew Fountain, Thomas Harriman, Steve Feldman, N.F. Tsang, Phelps Meaker, Meredith Warshaw, Richard Williams, Jonathan Aronson, Bill Habeck, Daniel Morgan, Chris Unger, Stephen Goldfeld, Peter Silverberg, Ken Rosato, John Chandler, Frank Carbin, Charles Whiting, and the proposer.

A/S 4. Ken Rosato's rocket accelerates from 0 velocity to C (the velocity of light, 186,000 miles per second) with a constant acceleration (relative to a

stationary observer) of $1g = 32$ feet per second². It carries a clock synchronized to an identical clock at rest with the stationary observer. When the velocity of the rocket reaches that of light, how far behind the stationary clock will the clock on the rocket be.

Bill Habeck realized that if we let t be the time in seconds then the difference in clock readings is

$$\frac{1}{g} \int 1 - \sqrt{1 - (gt/C)^2} dt.$$

He then evaluates the integral, using the substitutions $r = gt$ and $dr = gdt$, and obtains the answer $(4 - \pi)C/4g$.

Substituting for C and g yields 6,586,130 seconds or 76 days, 5 hours, 28 minutes, and 50 seconds.

Also solved by Richard Hess, Matthew Fountain, John Prussing, Chris Unger, John Chandler, and the proposer.

A/S 5. Our last regular problem comes from the February 1986 issue of *IEEE Potentials*, where it was attributed to Bruce Layman. An IEEE student entered the north end of a tunnel of length L . After walking the distance $L/4$ into the tunnel, he noticed a car approaching the north entrance at 40 miles per hour. The student knew his own speed and calculated that no matter which end of the tunnel he ran to, he would arrive there at the same time as the car. What is his top speed? Hint: he might do better as a professional athlete than as an engineer.

Gordon Rice sent us the following solution:

Let S be the student's speed, and D the distance from the car to the tunnel entrance. The basic relation is time = distance/speed.

To reach the near end of the tunnel, the student takes $L/4S$ and the car takes $D/40$. To reach the far end, the student takes $3L/4S$ and the car takes $(L + D)/40$. Solving $L/4S = D/40$ (thus $D = 10L/S$) and $3L/4S = (L + D)/40$, the L cancels out and we get $S = 20$ mph.

Presumably the tunnel is too narrow for the car to pass the student and too dark for the driver to see him in time to stop. The student's best chance to save his life is to run for the far end. As they approach the exit, the running student will be silhouetted against "the light at the end of the tunnel"; the driver will perceive him, brake, and maybe stop and give him a lift back to town.

Also solved by Theodosios Korakianitis, Richard Hess, Bill Habeck, Matthew Fountain, Jonathan Aronson, Harry Zaremba, Frank Carbin, John Chandler, Thomas Harriman, Ken Rosato, Gerard Weatherby, Stephen Goldfeld, Avi Ornstein, N.F. Tsang, Evan Klein, Phelps Meaker, A. Ostapenko, Raymond Gaillard, Thomas Lewis, Charles Whiting, Gardner Perry, Frederick Furland, Bill Cain, Richard Riley, Chris Unger, John Prussing, and Steven Feldman.

Better Late Than Never

A/S SD2. Some readers believed that Archimedes could have determined the walker's speed as the person approached. However, stories about Archimedes imply that when he worked on mathematics he was oblivious to approaching armies, let alone a single stroller.

Proposers' Solutions to Speed Problems

SD 1. The speed of sound 741 mph (when written in octal) and the speed of light 299792458 meters/sec. (when written in hexadecimal).

SD 2. 14272563125. $1^1 2^2 3^3 4^4 5^5$.

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I N T H E
1 9 9 0 S

NEW United Motor Manufacturing, Inc. (NUMMI), the General Motors-Toyota joint venture in Fremont, Calif., has shown that U.S. automakers can achieve Japanese levels of productivity and quality. As a result, NUMMI's "team concept" has become a model for work reorganization in the entire industry. General Motors is trying to spread elements of the NUMMI model to its plants across the country. Chrysler has negotiated "modern operating agreements" based on team organization at several plants. Even Ford, the most successful U.S. auto company in recent years, has begun to move toward NUMMI-style work systems.

But while the need to reorganize work has been accepted, actually implementing some version of the NUMMI model beyond a few demonstration plants has proven elusive. Successfully reorganizing work requires changing institutions that have shaped the auto industry for half a century—in particular, the system of labor-management relations established in the 1930s and 1940s between the United Auto Workers Union (UAW) and the auto companies.

Traditionally, management in the mass-production auto industry has been hierarchical and quite often authoritarian. This system is personified by the foreman who, functioning as a kind of "drill sergeant," enforces shop-floor discipline. Industrial unionism was a response to the abuses of that system. Union contracts spell out the rights of individual workers through detailed job definitions. Seniority systems ensure that favoritism is not a factor in assigning jobs. And formal procedures for grievance and arbitration offer a mechanism to resolve disputes.

Such provisions have given unions a particular kind of power on the shop floor—the ability to regulate job descriptions and assignments. But in exchange, they have ceded to management the right to run the business as it sees fit, a principle enshrined in the "managerial prerogative" clause of most union contracts.

Recent initiatives to reorganize work challenge this labor-management relationship. They weaken

traditional mechanisms for union power. Team organization usually means reducing the number of job classifications and allocating labor more flexibly, often at the price of weakening seniority protections and giving management wider discretion in assigning jobs. And fostering cooperation between labor and management means minimizing the use of formal grievance and arbitration, the traditional vehicle for the expression of union influence.

Of course, more cooperative forms of work organization can also lead to new kinds of union influence—in particular, a voice in decisions about how work is organized and how technology is used. This possibility has made reorganization attractive to some UAW leaders. However, unions have had little say in such decisions in the past, and today companies tend to reorganize work without much reference to union concerns.

In some cases, firms have tried to create Japanese-style plants while avoiding unionization altogether. Nissan and Honda have done this at their new facilities in Smyrna, Tenn., and Marysville, Ohio. And even at plants where unions have been established for years, local managers often attempt to reorganize work in a way that diminishes union influence.

This approach is shortsighted. In the long run, cooperation cannot be forced upon unwilling workers. The more managers use reorganization against the UAW, the more workers and the union will move to obstruct workplace changes such as teamwork.

For these reasons, the attitudes and actions of local management are crucial in determining whether work reorganization at a particular plant succeeds. Some high-level managers may have gotten this message, but they still have to persuade many middle managers and foremen who have not. Firms must convince not only their unionized workers but also

LOWELL TURNER, a former union representative for the National Association of Letter Carriers, is a research associate at the Berkeley Roundtable on the International Economy at the University of California. This year he is a doctoral research fellow of the Social Science Research Council and the Max-Planck-Institut in Cologne, West Germany, where he is comparing changes in work organization and industrial relations in the U.S. and German auto and telecommunications industries.

At NUMMI, management has provided a system of work and rewards that has earned the loyalty of most employees and local union leaders.

their own managerial personnel that reorganization is a good idea.

Such widespread organizational changes will be the product of a prolonged trial-and-error process. While it is too soon to know the ultimate result, three recent cases suggest some likely scenarios:

► At NUMMI itself, the team approach has been successful in part because Toyota managers realized how important it was to train their own staff in new ways of dealing with the work force. But even NUMMI has not developed exactly as managers had originally envisioned. In particular, the union plays a more independent role than is the case in Japanese auto plants.

► At the General Motors assembly plant in Van Nuys, Calif., the organizational innovations that have succeeded at NUMMI have so far fallen short—because of management's inability or unwillingness to reform its own practices. Managerial demands have sparked strong opposition among shop-floor workers.

► At GM's Plant #1 in Lansing, Mich., management and the local union have worked together to create a "homegrown" version of work reorganization that combines innovations like teams with features of traditional U.S. labor relations. This hybrid may be the most appropriate model for the U.S. auto industry.

THE team concept has made possible large improvements in quality and productivity at NUMMI's Fremont, Calif., plant. For many workers, it has also enhanced work life. Management has provided a system of work and rewards that has earned the loyalty of a majority of the work force and union leadership.

At NUMMI, job classifications are minimized, with production workers in one category and skilled-trade workers in two others—compared with over a hundred classifications in the original GM Fremont plant. Workers are divided into teams, usually of five, each with a leader who is a union member.

Team leaders are carefully selected and trained by management. They check parts and equipment, do some repairs, fill in for absent members, keep records, and otherwise coordinate work. That includes leading team meetings, looking for ways to foster quality and productivity, and encouraging members to provide suggestions for improving production.

Team members are usually trained to perform all the jobs assigned to their unit so they can help out as the need arises. They are expected to maintain high standards and find ways to make work more



CASE #1 NUMMI Winning the Loyalty of the Work Force

productive.

Under the NUMMI team system, management has considerable flexibility in assigning jobs. For instance, qualifications count more than seniority—although some workers complain that management decisions about who is most qualified are arbitrary. Group leaders, the first line of management, oversee several teams. They are equivalent to the foremen of a traditional auto plant, although the idea is that they should function as problem solvers rather than as drill sergeants. While many group leaders seem to understand that new role, some do not. For this reason, a worker's experience with teams can depend in large part on the attitudes and behavior of the group leader.

The union has a variety of formal and informal mechanisms for exerting its influence at the NUMMI plant. In addition to the 15 full-time union representatives, there are 67 union coordinators. These full-time workers, who are elected by their peers, solve labor-management problems on the shop floor, without recourse to the formal grievance procedure. When a conflict cannot be resolved in this way, it is referred to a full-time union representative, who decides whether to file a grievance. For-

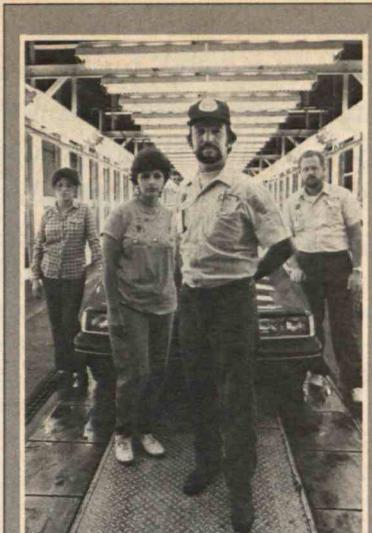
mal grievances do occur at NUMMI, although far less frequently than at a traditional auto plant.

Union leaders also regularly attend management meetings and participate at various levels of decision making. For example, they play a central role in hiring new employees. Finally, not only does the plant's union contract give workers wages comparable to those at other UAW-organized assembly plants, but it includes special provisions such as a promise not to lay off people except in the most adverse market circumstances. NUMMI made good on this promise when sales of the plant's Chevy Nova slumped badly last year.

In interviews with NUMMI workers, including opponents of the current local union leadership, I have yet to hear anyone express a preference for the old GM system. People like the fact that they are treated with some respect, turn out a high-quality product, work in a clean and efficient environment, and often find their advice and concerns actively solicited. Team leaders in particular are grateful to have more than just a job, and many thrive on their new leadership responsibilities and the opportunity to come up with creative solutions to production problems.

But this is not to say that NUMMI is a workers' utopia. The People's Caucus, an opposition group within the local union, has become a strong and visible force in the plant on the strength of its criticisms of the team system's limits. At NUMMI, caucus members argue, there is constant pressure to work harder and faster, not just smarter. They say that the close collaboration between union and management makes the two indistinguishable, and that as a result the union no longer provides strong representation for its members. Caucus members also maintain that the informal mechanisms for union involvement make for an undemocratic union, because they lead to too many closed-door meetings and behind-the-scenes deals between union leaders and management.

Whether these charges are true is a subject of lively debate within the work force at NUMMI. And yet supporters of the People's Caucus are careful to emphasize that they are also supporters of NUMMI and the team concept. They see themselves as striving to make the system better by making it more humane



NUMMI workers
found jobs and conditions that exceeded their expectations of life in an auto plant.

and more democratic.

When asked to explain workers' general support of the team concept, GM managers emphasize the "significant emotional event": before the plant opened as the site of the joint venture, it had been closed for two years. Workers who had been laid off returned to the facility humbled and grateful for their new jobs.

This may have influenced worker attitudes, but it's hardly the chief factor. Other plants have reopened without nearly the same kind of organizational success. Far more important is what workers face when they go back to work. At NUMMI,

they found jobs and conditions that in many ways exceeded their expectations of life in an auto plant.

Management, from the executives at the top to the group leaders on the shop floor, emphasized garnering worker input and gaining consensus. What's more, they offered tangible benefits such as employment security in return for worker and union cooperation. In this way, they won the commitment of workers and union leaders to the new plan.

Paradoxically, this outcome was not entirely management's doing. The original intent was to exclude the union, hiring a brand new, thoroughly screened, and pliable work force—just as Nissan and Honda have done at their U.S. facilities.

But the UAW was entrenched in the former work force at the Fremont plant and gained the right to represent workers at the new plant as well. The union convinced the GM-Toyota joint venture to give former Fremont workers preference in hiring. It also negotiated full-time union representatives, which at first the company opposed, in addition to the many shop-floor union coordinators. The union presence at NUMMI has contributed to acceptance of the team system and, so far, to its success.

Since the plant opened in 1984, local union politics have also shown the potential to push the NUMMI model in new directions. In June 1988 union elections, workers sent a sophisticated message to management. By reelecting the union leadership, they communicated their overall support for the NUMMI system. By giving People's Caucus supporters a majority of the union-coordinator slots on the shop floor, they underlined their desire for more aggressive protection of union rights within that system.

ONE plant where GM management has invested a major effort to adopt the lessons of NUMMI is the Van Nuys assembly facility in Los Angeles, but no glowing productivity, quality, or cost improvements have yet been advertised. By all accounts, the team system and labor-management relations at the plant face a rocky future. Van Nuys illustrates what happens when management polarizes workers in its push for reorganization and fails to adequately screen and retrain its own front-line supervisors and middle managers.

The Van Nuys facility produces about 200,000 Camaros and Pontiac Firebirds each year. Since these cars sell for about \$20,000 and thus occupy a specialty niche, the plant would seem to be a good candidate for multi-skilled and multi-task team organization. In 1986, the new manager Ernie Shaefer, previously in charge of the innovative Fiero plant in Pontiac, Mich., negotiated a labor agreement based on the team system with the union's shop bargaining committee. It included drastic reductions in job classifications and increased managerial flexibility in assigning jobs.

Management and cooperating union leaders presented the contract to the work force as a way to convince GM corporate headquarters that the Van Nuys plant, long threatened with shutdown, was worth keeping open. The rank and file rejected the agreement, but then the plant-closing threat was revived. Workers were inclined to take it seriously, since the second shift had already been laid off, and when they voted again, they passed the agreement by a small margin.

With the help of \$20 million from California's Employment Training Panel, 125 workers were taught to be instructors. Then 1,100 team leaders were selected and trained for 10 weeks in the team concept. Finally, in May 1987, the entire remaining work force on both shifts received seven days of training, and the new system went into effect.

However, support for the agreement was never widespread, either in the work force—as the close



CASE #2

VAN NUYS

Managers Force
Participation

margins of the two votes suggest—or among the local union leadership. And one month after the introduction of the system, a hotly contested local union election ousted the pro-team shop chairman (the highest UAW official in the plant). He was replaced by the previous local president, an opponent of the new agreement, who proceeded to pull the union out of all the joint labor-management committees that had been set up to administer and facilitate the team system.

Management responded by trying to move around the new shop chairman and his allies, with some success. Managers drew into the team process whoever was willing to participate, including other members of the union bargaining committee and team leaders. The new local union president led the union efforts to make the team system work.

Tension reached a high point in the spring of 1988 in a rapid series of events: First, Van Nuys management fired the anti-team shop chairman, allegedly for lying about past absences. Then, the company unilaterally announced that the plant's seat-cushion operation would be farmed out to a subcontractor—at a cost of 130 union jobs—hardly an action designed to win labor's trust. Finally, Ernie Shaefer was transferred to a new assignment, raising doubts among both managers and workers about GM's commitment to the plant and the reorganization process. The new plant manager claims he fully supports the work-reform efforts, but tensions remain high.

Managers tend to explain away the problems at Van Nuys by saying that because the plant has never been closed, the work force hasn't suffered enough to be willing to embrace the new system. But workers at Van Nuys have in fact suffered through considerable uncertainty and dislocation. The entire second shift, half the work force, has been on long-term layoff. Moreover, some of the workers are recent transfers from other plants that have closed, and for years GM has threatened to close the Van Nuys facility as well.

Another common managerial explanation for the

At Lansing, labor-management cooperation has improved productivity and the quality of work life without assaulting traditional union protections.

Van Nuys failure is that the strong organized presence of union militants at the plant has made the plan unworkable. Even before the introduction of the team concept, union representatives and workers from Van Nuys had organized an active "labor-community coalition" to keep the plant open in the face of GM's threats to close.

However, this argument assumes that union activists will necessarily oppose labor-management cooperation. In fact, a number of coalition supporters have become team leaders and advocates of the new system. And at NUMMI, former militants from the old GM plant head the cooperation-oriented local

union leadership.

The main difficulty at Van Nuys is not worker resistance but management's failure to reorganize itself for the tasks at hand. By contrast, management at NUMMI has taken a genuinely new approach, characterized in part by comprehensive attention to human relations. Both Van Nuys workers and NUMMI visitors to the plant—sent down by GM and the UAW to assist reform initiatives—say that management has asked for a major transformation of worker attitudes and job descriptions while on the shop floor its own personnel often cling to the same old authoritarian styles.

GENERAL MOTORS' Plant #1 in Lansing, Mich., where the Pontiac Grand Am is made, has not received the publicity that NUMMI and Van Nuys have. Nonetheless, it is just as much an experiment in work reorganization. In this case, the new system is a result of an evolving cooperative relationship between the local management and local union. The reforms enhance the quality of work life and improve productivity without assaulting traditional union protections. Workers and union representatives have responded with widespread support.

At Lansing, the team system looks rather different than at NUMMI or Van Nuys. Teams are larger, consisting of 10 to 25 members, and the full-time team coordinators are selected by seniority. What's more, participation in weekly team meetings is voluntary but popular, with interest high in the discussions of production, quality, labor-management relations, and general business developments. There are also more job classifications at Lansing than at NUMMI, although far fewer than at traditional auto plants. Several people at the plant have emphasized to me that the number of classifications is less important than getting people to work together as a team.



CASE #3
LANSING
"Homegrown" Cooperation

All the changes at Lansing have been carried out without a number of the conditions usually considered necessary for the success of team systems: job rotation, promises of employment security, weakened seniority rights in job allocation, or the "significant emotional event" of a plant closing.

A key factor has been the innovative approach of plant management, led since 1985 by Frank Shotters, a self-proclaimed "participatory manager." To enhance direct communication and clear responsibility, managerial levels have been cut from seven to four. All management staff meetings are open to the union. And managers at all levels have gone through a re-training program to replace authoritarian attitudes with a more participatory approach. Cooperation does seem to be increasing throughout the plant. Union representatives are regularly drawn into discussions and decision making right up to the level of the plant

manager.

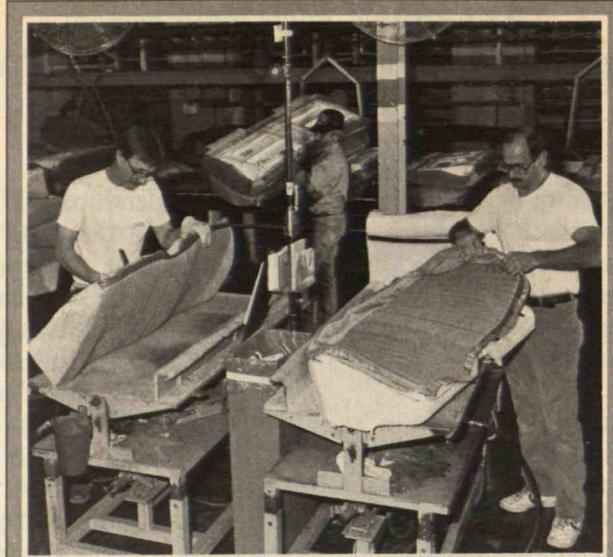
Both management and union have also chosen to persuade the workers that a team approach is worthwhile instead of simply imposing it on them. For example, in 1986, soon after teams were introduced, workers voted to make participation in them vol-

untary. As a result, participation dropped to a meager 30 percent. But neither union leadership nor management responded with stepped-up pressure and a second vote as is common in other GM plants. Rather, both set out to convince Plant #1 employees that the team structure could give the work force a new way to express its views. As a result, the voluntary participation rate is now in the range of 80 to 90 percent.

Managers and union representatives are quite conscious of Lansing as an alternative to NUMMI. At other team-oriented plants, they say, top management makes a decision and then groups of lower managers and workers discuss it until they all agree. At their plant, by contrast, workers, lower-level managers, and union representatives are consulted before decisions are made. And all groups are encouraged to participate in the decision-making process itself—from minor shop-floor decisions to strategic planning that affects the entire plant.

Given the established features of industrial relations in the U.S. auto industry, Lansing may represent a more suitable model for work reorganization than NUMMI's Fremont, Calif., plant. And the comparison between Lansing and Van Nuys is especially instructive. At Van Nuys, management's heavy-handed intervention in union politics may have induced slightly more than half the work force to accept a NUMMI-type system, but the price has been backlash and resistance on the shop floor. At Lansing, on the other hand, extensive labor-management cooperation has created a broad consensus in favor of work reorganization.

The difference between Lansing and Van Nuys can be seen in the response to last year's poor sales. At Van Nuys, management proposed an innovative lay-off agreement. Instead of laying off workers strictly according to seniority as mandated by the union contract, the plan called for sharing the burdens and benefits of the layoff among the entire work force. Doing so would allow the plant to alternate shifts on layoff and keep its teams together. Workers re-



Facing pressure from corporate headquarters to farm out the production of seat cushions, employees at GM's Plant #1 in Lansing devised a plan to organize work

more efficiently. Local management accepted their proposals and found new assignments for the few people displaced.

sponded with distrust, seeing the proposal as yet another attack on seniority rights. It took a bitter political debate and, once again, two votes before Van Nuys workers narrowly accepted the package.

At Lansing, the principle of seniority rights is not subject to debate, and a nearly identical plan was perceived for what it was—a relatively fair way to spread the costs of the layoff while keeping the plant as productive as possible. The proposal passed by 90 percent.

Management at the Lansing plant also faced pressure from GM corporate headquarters to cut costs by assigning the production of seat cushions to subcontractors, as happened at Van Nuys. But plant managers took the problem directly to the union and the workers in the cushion room. After months of joint discussions and brainstorming, the workers came up with a plan to organize work in the cushion room more efficiently, cutting a few jobs to save the rest. Management accepted the proposals, found new assignments for the few people displaced, and now says it will resist corporate pressure to farm out seat-cushion work.

A New Quid Pro Quo

Lansing is not an isolated case. GM facilities such as the Lordstown, Ohio, assembly plant are developing similar homegrown versions of work reorganization. However, for every Lansing or NUMMI shooting out of the starting blocks, several more plants stumble along face to the ground. At some, management has hesitated to initiate major reorganization efforts for fear of causing new conflicts and disrupting production. And at others like Van Nuys, management has used high-pressure tactics to impose the team concept—hardly an approach that fosters the trust necessary for encouraging workers to become involved in problem solving and decision making.

Probably the greatest barrier to effective work reorganization in the auto industry is management's failure to adequately reform its own practices. To

make teams work, managers have to see reorganization efforts as an opportunity to involve the union, not defeat it, and to move decisively away from the authoritarian tradition of the past. A crucial first step would be to retrain current managerial personnel, screen new candidates for supervisory positions more carefully, and weed out uncooperative managers.

Whatever management's strategy, work reorganization will still pose serious challenges to U.S. unions. The UAW's national leadership has supported the move toward new working arrangements and generally assisted local unions that have negotiated experimental labor agreements with management. But it remains unclear whether the union can deliver on the promise to improve quality of work life throughout the entire industry. Indeed, as the various models of work reorganization multiply and locals devise different agreements at different plants, there is danger that the UAW will become more fragmented, thus diminishing its national power.

The most important task for the union is to develop its own vision of work reorganization—one that speaks to workers' aspirations for improved working conditions and more challenging jobs, as well as to management's imperative to create efficient work systems. Insisting on substantial participation in reorganization efforts before renegotiating local labor contracts would lay the foundation for a national union strategy equal to the competitive challenges of the auto industry in the 1990s and beyond. ■

PROBLEM: SOLVE FOR SURFACE TEMPERATURE FOR SMALL ϵ

(C1) $EQ: E^*(T^4 + 2328 \cdot T^3 + 2032344 \cdot T^2 + CQ \cdot T^{(5/4)} + 788549472 \cdot T) = QFLUX$

(D1) $E(T^4 + 2328 \cdot T^3 + 2032344 \cdot T^2 + CQ \cdot T^{(5/4)} + 788549472 \cdot T) = QFLUX$

(C2) TAYLOR_SOLVE(EQ, T, E, 0, [3]):

(D2) $T = \frac{E}{4} \cdot \frac{582}{(E - 1/4)^{7/16}} + \frac{CQ \cdot E^{1/4}}{4 \cdot (E - 1/4)^7} + K_0 = QFLUX$

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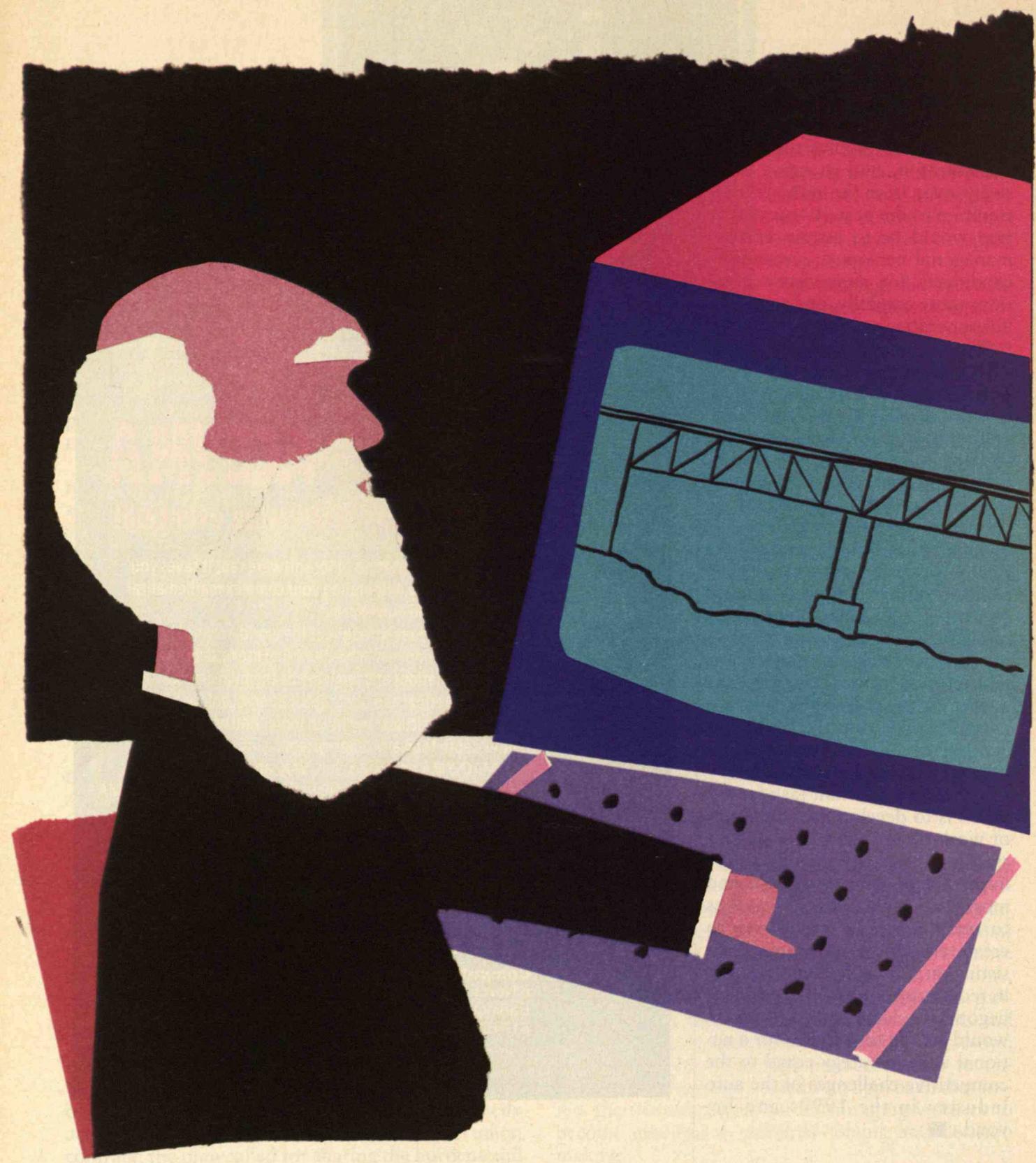
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Genetic Algorithms:

What Computers Can Learn from Darwin

An approach to programming that mimics evolution may solve problems better than artificial intelligence can.

Afew billion years ago, after the earth had cooled enough for water to be a liquid, the first molecules of life began to replicate themselves. They contained practically no genetic information at all. Yet they had embarked on a process of evolution that would produce an enormous diversity of genetic information—enough to specify every characteristic of every creature that now inhabits the planet.

The force at work here is an algorithm, a set of instructions that is repeated to solve a problem, just as the steps of long division are repeated until they yield a satisfactory result. The algorithm behind evolution solves the problem of producing species able to thrive in particular environments.

This same genetic algorithm can solve many other kinds of problems as well. It forms the basis of an emerging field of computer programming that could challenge expert systems. Research is under way on adapting the genetic algorithm to such applications as running pump stations on oil pipelines, eliminating distortion from x-ray images, and designing very-large-scale integrated (VLSI) computer chips.

To design a VLSI chip, for example, you would first devise a way to describe a chip design by a string of digits, a "chip chromosome." Sections of this chromosome—"genes"—would represent

the chip's subassemblies. You would begin the design process, as evolution did, with a random list of chip chromosomes, each specifying a complete but unorganized set of electrical and data processing properties. Most of these chance designs would be very poor. But you would use a straightforward mathematical process to choose a few of the best ones.

Then, just as surviving organisms reproduce in nature, you would mate the chromosomes of the most efficient chips—combining different parts of different chromosomes to produce "offspring" chromosomes with characteristics derived from their "parents." From this second generation you would again select the most efficient and eliminate the rest. You might also apply an occasional mutation—a random change in one of the genes. This process of mating, mutating, and selecting would continue until it arrived at a good design.

The field of computing based on the genetic algorithm was pioneered 25 years ago by John Holland, a computer scientist at the University of Michigan. Holland began with an interest in what are called cellular automata. These are elementary computing programs, simple enough to be modeled on graph paper. The "cells," or grids, are filled in or erased according to a few simple rules. The resulting diagrams grow, move, or disappear in unpredictable ways, and when

BY CHARLES T. WALBRIDGE

If solving problems through natural selection sounds like a dubious proposition, think of all the parlor games that do the same thing.

made complex enough, they can even reproduce. Thus, after a fashion, they resemble the first life forms that congealed out of the earth's primordial seas. In time Holland moved from the growth and reproduction of programs to the *evolution* of programs, the foundation of genetic algorithm research. Today, though still dominated by computer scientists, the field is drawing more and more contributions from such disciplines as engineering, mathematics, and biology.

Many of the practical problems in such areas are also being tackled by expert systems, a form of artificial intelligence that seeks to computerize precisely defined areas of human expertise. But there is a vast difference between the two approaches. An expert system is based on numerous logical deductions and incorporates complex rules gleaned from a human expert—a medical diagnostician or a geologist or a diesel mechanic. Getting such information out of the expert's head and into a form that can be processed by a computer is a major bottleneck.

With the genetic algorithm, programmers do not need expertise in a specific area. They merely need a way to test many trial solutions to ascertain quickly how well any one meets established criteria. Devising such a test is relatively simple. For example, evaluating the efficiency of a given chip design is far easier than trying to design an efficient chip from among the countless possibilities. The beauty of the genetic algorithm is that once the criteria are in hand, the computer itself gropes around in a trial-and-error fashion, keeping track of its best guesses, building on them, and eventually producing a good answer.

Playing Games

If solving problems through natural selection sounds like a dubious proposition, think of all the parlor games that do the same thing. In Battleship, which is really just a sophisticated version of Hot and Cold, each player has a fleet of "warships" deployed on a grid but doesn't tell the other where they are. One player calls out coordinates (a "gene") representing where a shot will land. The opponent tells the player

whether the shot was a hit or a miss (how "good" the gene is). This feedback, like that provided by natural selection, allows players to save the better solutions and improve on them in the effort to wipe out the opponent's fleet.

I have put together a game called Vector to illustrate the genetic algorithm in more detail. It takes two to play. Your opponent secretly writes down a string of six digits, each either a 0 or a 1. You suggest strings and your opponent scores them, the score being the number of digits in a string that match the secret string. The object is to match the secret string—i.e., to get a score of 6—by asking as few questions as possible.

Start by writing four random trial strings. For example:

TRIAL STRINGS	SCORES
A) 010101	1
B) 111101	1
C) 011011	3
D) 101100	3

Now delete the low scorers (A and B) and subject the high scorers (C and D) to "genetic operators" analogous to those found in nature. First, apply "multiplication"—simply duplicate C and D, so you have four high scorers. Group the four in pairs that are, in effect, parents:

MULTIPLICATION

- C) 011011
- D) 101100
- C) 011011
- D) 101100

Then mate these parent genes through "crossover." Cut each at an arbitrary point and splice the first part of the "father" (C) to the second part of the "mother" (D) to produce one "offspring" (E). Splice the first part of the mother to the second part of the father to produce another offspring (F). Now cut the father and mother at a different point to produce a second set of offspring, and have your opponent score each offspring:

CHARLES T. WALBRIDGE has been working for the U.S. government on aquatic toxicology for 25 years. His interest in genetic algorithms resulted from a search for more efficient ways to predict the effects of toxic wastes on fish populations. He is now trying to extract the "rules" of toxic effects directly from field data rather than from laboratory tests.



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A successful problem-solving method doesn't have to be smart, just capable of accumulating what works and rejecting what doesn't.

CROSSOVER	OFFSPRING	SCORES
C) 01:1011	E) 01:1100	3
D) 10:1100	F) 10:1011	3
C) 0110:11	G) 0110:00	4
D) 1011:00	H) 1011:11	3

So far you have received eight scores on your two lists of strings; in effect, you have asked eight questions. Taking two of the top scorers—say, F and G—repeat multiplication and crossover, and have the offspring scored:

CROSSOVER	OFFSPRING	SCORES
F) 1:01011	I) 1:11000	3
G) 0:11000	J) 0:01011	5
F) 101:011	K) 101:000	4
G) 011:000	L) 011:011	4

With a score of 5, you are almost there. Now repeat the process on two high scorers:

CROSSOVER	OFFSPRING	SCORES
J) 0010:11	M) 0010:00	5
K) 1010:00	N) 1010:11	4
J) 00101:1	O) 00101:0	6
K) 10100:0	P) 10100:1	3

Eureka! A perfect 6! The genetic algorithm has found the secret string.

You had to ask for scores on just 16 strings. You didn't have to try every one of the 64 possibilities (or even 32, the likely number required on a random search). In Vector or Battleship, the information returned in each step—the score or the answers "hit" or "miss"—is added to the information from previous steps. This makes it unnecessary to search the entire field of possible answers. Each trial after the first is less and less random.

Actually, it is misleading to say information is "added." The increase is more nearly geometric, as

illustrated by the game of Twenty Questions. In this example of the genetic algorithm, you ask yes-or-no questions to determine an object your opponent has thought of. Suppose, for example, your first question (a common one) is whether the object is living. Either answer automatically eliminates an enormous class of possibilities. The more possibilities each question eliminates, the faster you reach an answer. If the increase in information were merely additive, you could not possibly pin down an individual object from among countless options by asking only 20 questions.

This efficiency is due to "intrinsic parallelism": once you eliminate bad parent strings, you automatically eliminate their offspring, the offspring of their offspring, and so on. One operation does many tasks in parallel because it is evaluating present and potential strings simultaneously. Similarly, in evolution when less hardy members of a species die before adulthood, they produce no succeeding generations. Myriads of poor combinations of genes are eliminated, and natural selection operates only on a relatively small number of promising genes.

It is this power of intrinsic parallelism that makes the genetic algorithm so effective and allows it to zero in rapidly on a good solution.

The Role of Mutation

In this game of Vector, one genetic operator was left out: mutation. Mutation in the genetic algorithm is an arbitrary change in a given digit in a string, much as a mutation in nature is an arbitrary change in a gene. Mutation is sometimes needed to keep the algorithm from getting "stuck" at a less-than-optimal answer. Suppose that in playing Vector you had chosen four initial strings with a 0 in the third position. No amount of multiplication and crossover could have produced the 1 that the secret string contained in that position. You would have had to invoke mutation.

To avoid such a dead end, computer versions of the genetic algorithm are programmed to include a small possibility—say one in a thousand—that an "error" will occur in a multiplication operation, turning a 0 to a 1 or vice versa instead of copying it faithfully. Similarly, nature includes the small possibility of a genetic mutation in reproduction.

As useful as mutation is, its role should not be exaggerated. Many biologists still believe that evolution operates only through a sudden change in the genet-

ic material—a mutation producing an organism significantly different from any of its ancestors. In other words, the simplest one-celled forms would have evolved into human beings random mutation by random mutation. This seems impossibly slow, and in fact it is. Darwin himself recognized a need for a much shorter path to present-day biological complexity.

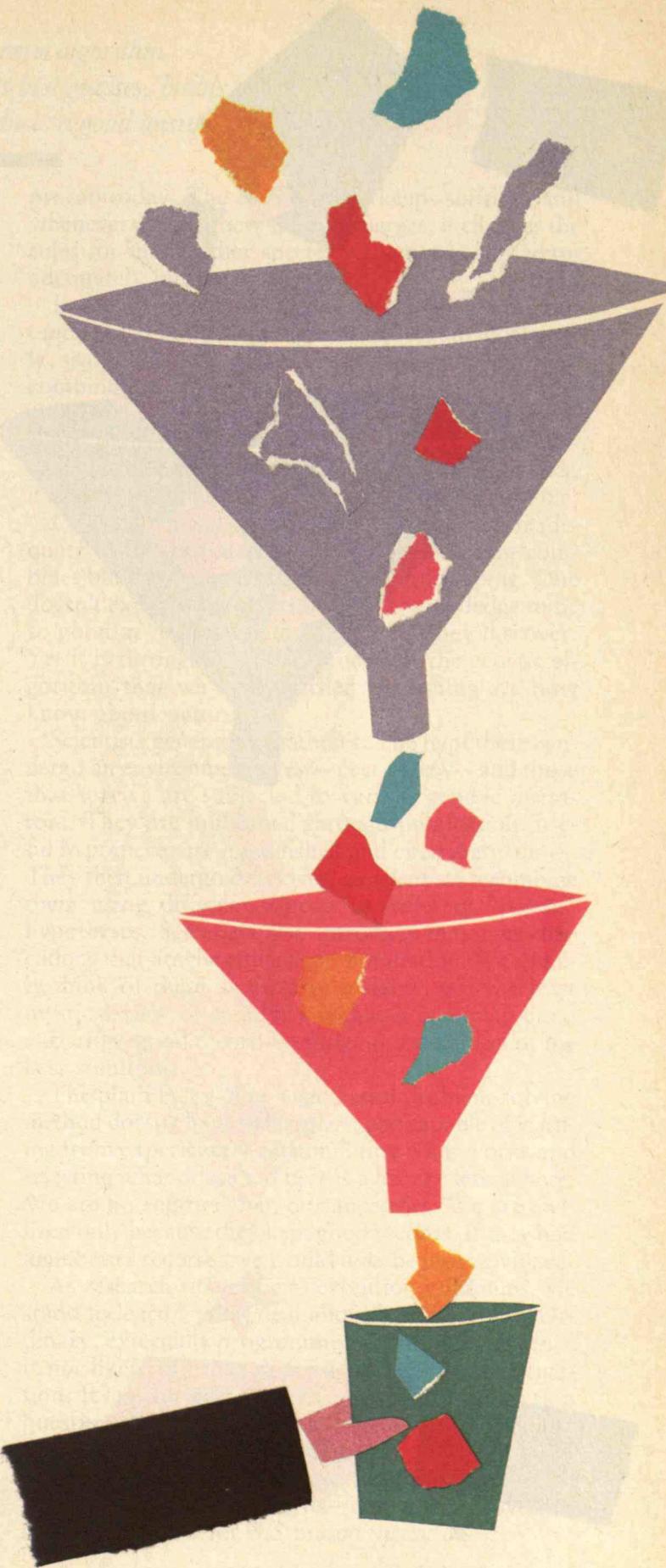
A simple calculation shows why. DNA is made up of 4 nucleic acids, in essence a 4-bit code. The 48 chromosomes that define a human being contain 3 billion of these bits. Thus, if nature had produced humans through mutation alone, it would have had to test $4^{3,000,000,000}$ different combinations of bits. Since mutations are relatively rare, the evolutionary process would have taken much longer than the present age of the universe, let alone the earth. And if the mutation rate had been high enough to generate all these variations during the short tenure of life on earth, the resulting organisms would not have been able to reproduce effectively.

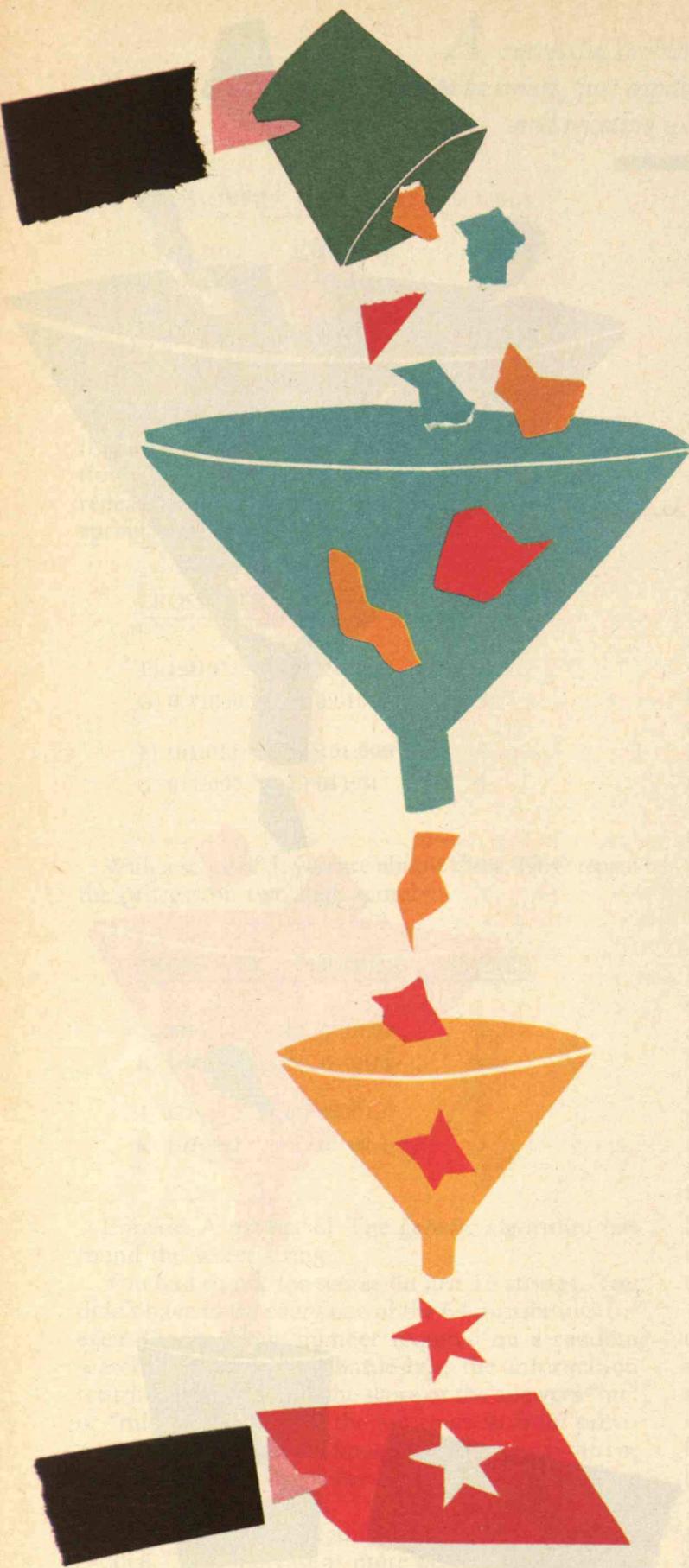
The workhorse of evolution, then, is not mutation but genetic recombination. This includes sexual reproduction, which recombines complete chromosomes from different parents; it also includes crossover, which recombines genes from different chromosomes. In nature and computing alike, what drives the process forward is the combination of the best features of the existing population and the elimination through implicit parallelism of the offspring that combine the worst features. Mutation attracts a lot of attention because it is obvious and frequently surprising, but its only real function is to restart a process of evolution that has stalled.

Putting Evolution to Work

Much as evolution applies the genetic algorithm to improving species, we can apply it to solving practical engineering problems. Probably fewer than 500 researchers are working with this algorithm, yet a remarkably diverse group of uses is emerging. One example is a program for designing a truss—a frame of struts that supports a bridge, roof, or other structure. Developed by David Goldberg and Manohar Samatani at the University of Alabama, it uses the genetic algorithm to produce a design that can support the required load with a minimum of material.

In the program, a 10-member truss is represented by a string of 10 numbers, each number being the diameter of a particular strut. The program starts by





randomly generating several hundred strings incorporating different strut diameters. An ordinary computer-aided design system then evaluates each string by calculating the weight of all the struts and the load they can carry. If the truss represented by a string cannot support the required load, the string gets a zero. If the truss can support the required load, then the lower its weight the higher the score.

Of course, these first strings score poorly; some trusses are too weak, others too heavy. But as the genetic algorithm saves the better strings and recombines them, the scores rise. Eventually they reach a plateau, signaling that the design is not likely to get better. Implicit parallelism allows the genetic algorithm to zero in on a good solution—a strong but light truss—in a reasonable time. Other programs to design trusses can produce similar results, but they are more complicated and must embody far more engineering expertise.

The genetic algorithm also can be used to design schedules for complex operations. Michael Hilliard and Gunar Liepins, who work on cognitive systems at Oak Ridge National Laboratory, have taken on the problem of scheduling production in a job shop. Such a shop uses drills, lathes, milling machines, and other tools to make metal parts, usually for industrial customers. The products, or "jobs," take different routes through the shop, and often two or more seem to require the same machine at once—a major scheduling headache. Somebody must develop a new production schedule every day, as well as any time a machine breaks down.

For a schedule to be described by a string of digits, certain constraints must be imposed so that all the schedules are realistic. For example, no machine can be used for more than one job at a time. Different strings representing schedules are generated, and a program selects those that would produce the maximum value of hourly output for the job shop. These "survivors" are crossed over, with occasional mutations, and the process repeats until it produces a good schedule. From the job shop it is only a short leap to other scheduling applications, such as helping colleges fit as many students as possible into the classes they want to take.

Another promising application is pattern recognition. A major goal of machine intelligence research is to develop systems that can distinguish a known pattern from "background," whether this is a matter of recognizing a face in a crowd or understanding

With the genetic algorithm, the computer keeps track of its best guesses, builds on them, and eventually produces a good answer.

spoken language. Researchers are discovering that the genetic algorithm is more efficient than most other computer techniques at sorting out distorted or "noisy" images. At Vanderbilt University, for example, Michael Fitzpatrick and his colleagues use the technique to match up "before" and "after" x-rays. It's possible to inspect an artery for lesions by injecting a dye and comparing the x-ray films taken before and after the injection. But accurate comparisons are difficult because the artery in the second image is never in exactly the same place as in the first. It may be displaced or even slightly twisted.

The second image can be "undistorted" by a transformation equation—an equation that moves each tiny point in a digitized image just the right amount so that it matches the point in a reference image. The problem is coming up with the right equation for a particular image. The Vanderbilt team has found that a program based on the genetic algorithm can quickly home in on a suitable equation. Starting out with many possible equations, it cycles through the genetic operators until it produces an equation that manages to align the second image with the first.

The speed with which the genetic algorithm can find solutions allows it to "learn"—to adapt to changes in its environment in a way that expert systems cannot. For example, David Goldberg of the University of Alabama has developed a program to cope with the ever-changing demands of an oil-pipeline pumping station. Running a pumping station is an art, not a science. Faced with fluctuating input—because of pump breakdowns, line leaks, and daily and seasonal pressure changes—the operator must learn how to adjust the pumping equipment to maintain a steady output. Goldberg's program for running a pumping station finds a combination of pumps and pressures that will achieve the desired output. As the input changes, the genetic algorithm automatically searches for a new combination that will produce the same flow as before. In essence, it learns to compensate; it trains itself.

Nothing's Perfect

In all of its uses—natural or artificial—the genetic algorithm can produce good solutions, but never perfect ones. This is largely because the criteria for success keep changing. The important questions may be eternal, but the answers aren't. Life began evolving under very different conditions from those that

prevail today. The environment keeps shifting, and whenever a major new species emerges, it changes the rules for many other species. Organisms can adapt adequately but never perfectly.

In theory, you could repeat the crossover and mutation cycles of a genetic algorithm program indefinitely, searching for the perfect chip design or the perfect combination of oil pumps. But in the meantime, the chip market or the pipeline flow will have changed. Your "perfect" solution will be obsolete. As far as evolution is concerned, very good is good enough. In fact, it is better than perfect, because it is more adaptable.

Of course, many people might doubt that even adequate results can arise from an approach that combines blind groping with precise record keeping. One doesn't expect systems with so little knowledge to be so good at retaining and using what they discover. Yet it is through a process much like the genetic algorithm that we have learned everything we now know about nature.

Scientists generate hypotheses. The hypotheses undergo an environmental test—peer review—and those that survive are subjected to various genetic operators. They are multiplied through publication; useful hypotheses are republished and cited many times. They then undergo crossover, as scientists recombine them using different aspects of different "parent" hypotheses. Scientists also introduce major modifications that are the equivalent of mutation. We usually think of these as creative insights, but the least mystical view of creativity is that it is merely blind variation, good record keeping, and retention of the best solutions.

The plain fact is that a successful problem-solving method doesn't have to be smart, just capable of learning from experience—accumulating what works and rejecting what doesn't. There is a history lesson here. We are no smarter than our ancestors. We are civilized only because they kept good records. If they had kept better records, we would now be more civilized.

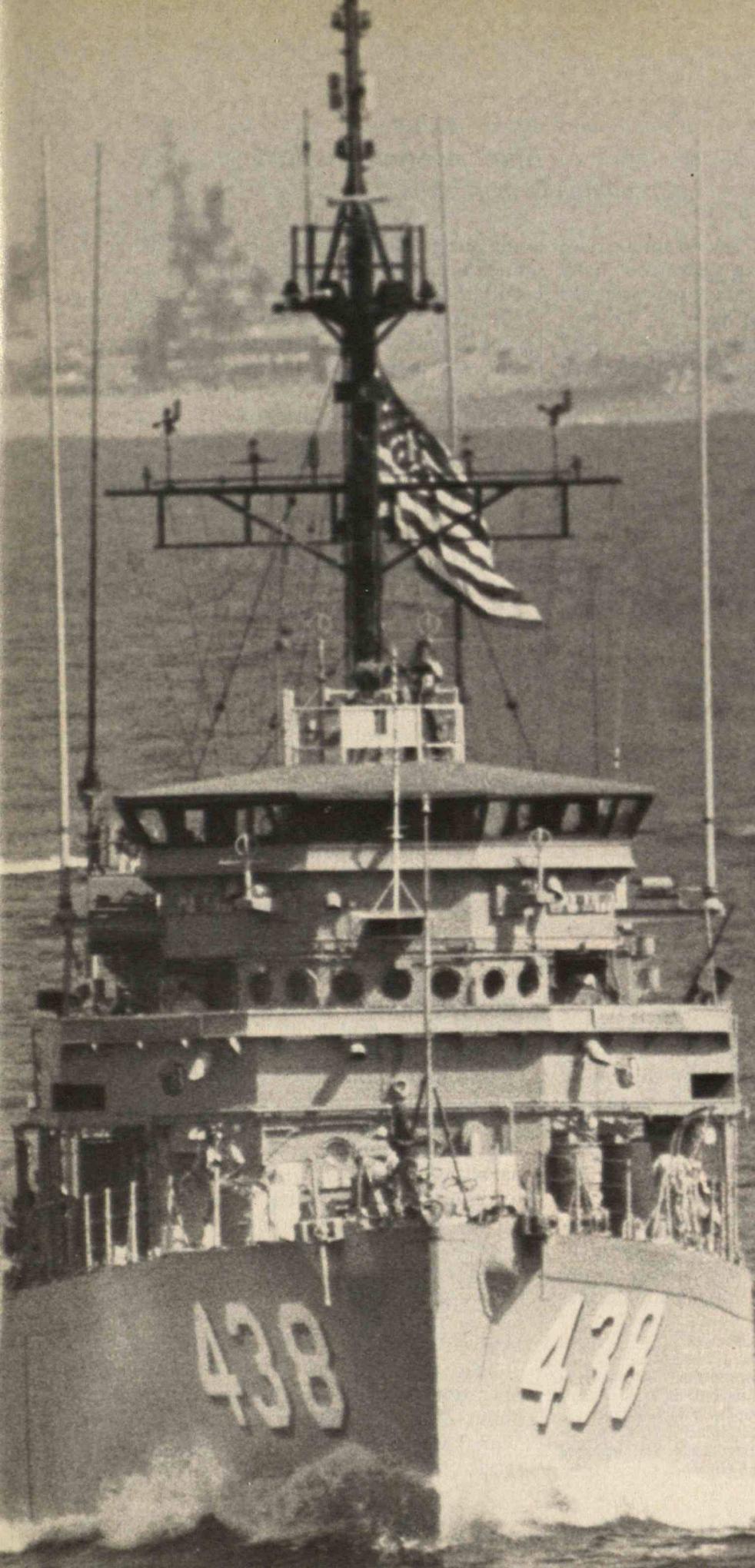
As research on artificial evolution continues, we stand to learn a great deal about learning itself. Ordinary, externally programmed artificial intelligence is not likely to prove as fertile an area of investigation. It lags far behind our own minds. If you ask a question that is even slightly outside a system's narrow expertise, artificial intelligence quickly turns to artificial stupidity. In contrast, the genetic algorithm learns and learns and learns—and it has proved itself in field tests for 3.5 billion years. ■



Troubled Waters:

The Navy's Aggressive
War Strategy

BY WILLIAM M. ARKIN



As recent incidents have shown, the U.S. Navy's strategy is provocative and destabilizing. The time is ripe for naval arms control.

SINCE the beginning of the Reagan administration, the U.S. Navy received preferential treatment. The president's commitment to unchallenged maritime superiority for the United States laid the foundation for an expensive program to expand the Navy to 600 ships. It also allowed the development of a controversial "Maritime Strategy," the Navy's peacetime plan to prepare for a protracted, conventional global war with the Soviet Union.

John Lehman, until recently secretary of the Navy, was point man in promoting these

Some observers are saying that the Navy's aggressive Maritime Strategy is dead. They couldn't be more wrong.

parallel revitalization programs, but in interservice and congressional budget battles he ruffled many feathers. When the Maritime Strategy was attacked as a potential precipitant to nuclear war, he provoked hostility—even among some supporters—by dismissing his opponents as living in “ivory towers” and calling them “armchair strategists” and “parlor-room Pershings.” Thus his critics in Congress and the Defense Department have been pleased to see the Navy receive \$20 billion worth of cuts in its fiscal 1988 budget and \$32 billion cuts for 1989.

These were more than cost-saving measures; they were also a pointed signal to the Navy that its unprecedented autonomy in the Reagan administration was ending. The drive for a 600-ship Navy has been stalled, leading to the resignation of both Lehman and his successor, James Webb.

Some are saying that the aggressive new war-fighting strategy is dead as well. They couldn't be more wrong. Today there are few constraints on naval nuclear weapons or operations, no outlawed maneuvers, no geographic restraints, and no proscribed strategies or doctrines.

Despite many cutbacks from the Navy's glory days of 1983 to 1985, the naval arms race continues. The U.S. Navy now has 565 combat ships, up from 480 in 1980. Amidst an unfettered naval arms race, nuclear-armed navies continue to confront each other regularly throughout the world. And recent incidents in the Persian Gulf have dramatized what to expect for the future when naval forces are mobilized as a first resort in crises in the Third World. With the further reduction in defense spending that is anticipated in the Bush administration, and the public doubts that have been raised about the wisdom of the Maritime Strategy, the climate is improving for a new course.

The Maritime Strategy

Officially adopted in 1982, the Maritime Strategy assigns the U.S. Navy three main tasks in the event of international crisis or war. First, U.S. ships would destroy Soviet attack and cruise-missile submarines

and surface ships before they could “surge” to the open oceans and threaten Allied naval forces. Second, the Navy would pin down Soviet ground and air forces around the world, escalating the conflict geographically and draining Soviet resources away from the main focus of military operations, most often said by war planners to be central Europe and the Middle East. Finally, the strategy calls for the Navy to destroy Soviet ballistic-missile submarines—the main offensive arm of Soviet naval power and a part of the intercontinental strategic strike force of the Soviet Union.

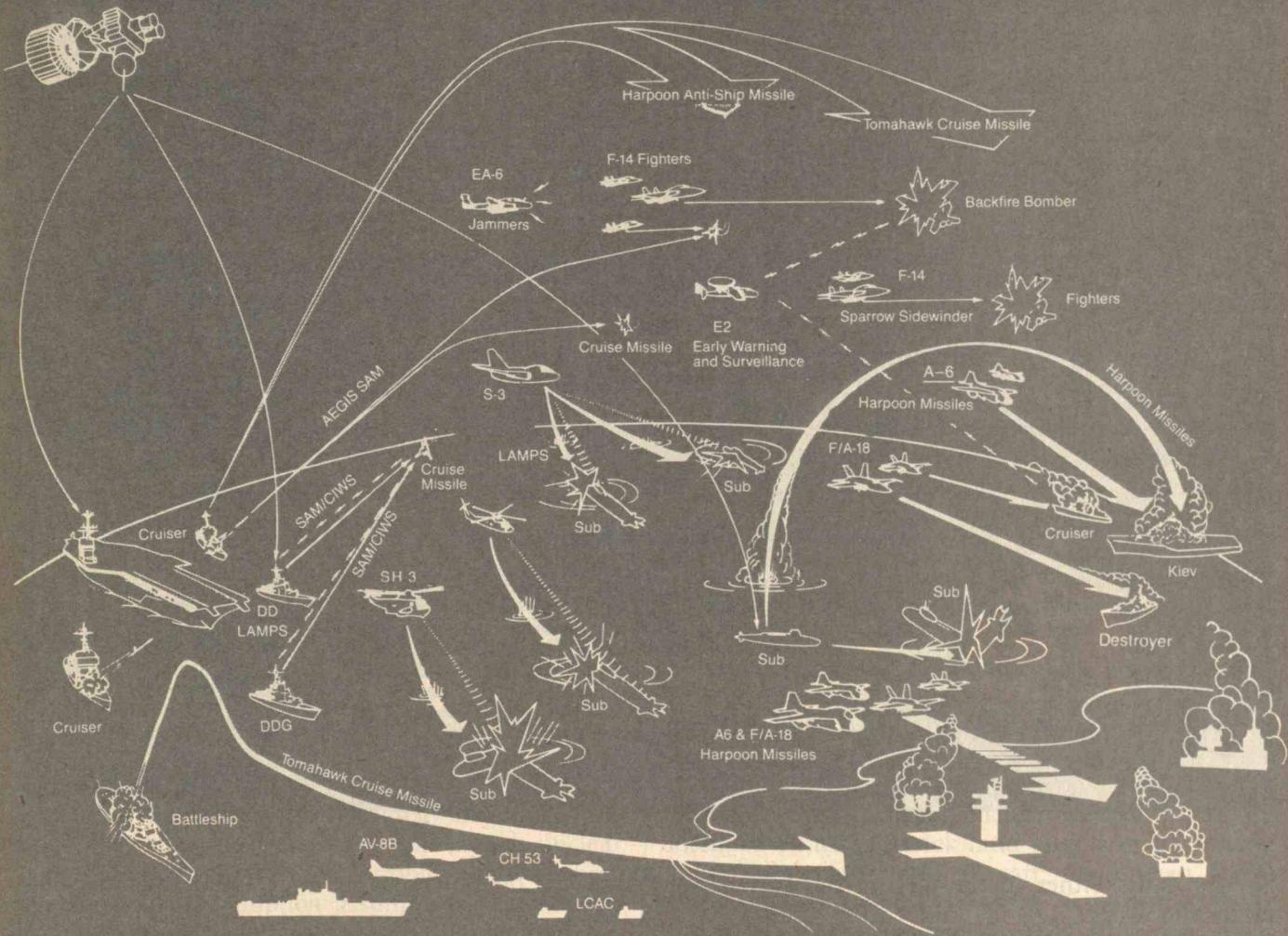
The Maritime Strategy is designed to capitalize on the weaknesses of the Soviet Navy. The Soviet Union is a land power, restrained by remote ports that lack direct access to the high seas. Ice impedes almost every Soviet coastal city in winter, except for bases in the Black Sea, the Baltic Sea, and the Barents Sea. Even in good weather, Soviet naval forces must funnel through natural “choke points” to open waters.

U.S. and Allied strategy takes advantage of these choke points by stressing “forward” operations during both peacetime and a crisis. Early in a confrontation, fast-moving Western submarines and ships would attempt to close the choke points, bottling up the Soviet fleet. The main naval battles would then be fought over control of the oceans and the land bases that dominate the narrow straits.

To support its three main tasks, the Maritime Strategy includes strikes against military bases inside the Soviet Union. Capt. Linton Brooks, a staff member of the National Security Council, wrote in 1986, “As the Soviet fleet is eliminated, both carrier strike aircraft . . . and nuclear Tomahawk missiles will be in a position to threaten the Soviet homeland.” Marine Corps land assaults on the flanks of the Soviet Union are planned as well. According to former Marine Corps commandant Gen. P.X. Kelley, “Massed naval task groups will undertake attacks on Soviet forces and their supporting infrastructure in Eastern Europe and the Soviet homeland . . . helping to induce a measure of fear, uncertainty, and paralysis into the Soviet warfighting machine.”

In accordance with the Maritime Strategy, the United States and its major allies keep their navies at a wartime cadence. “Although technically we are at peace,” Adm. James Watkins, then chief of naval operations, stated in 1985, “our operating tempo is about 20 percent higher than during the Vietnam War.” Moreover, says Watkins, “unlike any other service, the Navy runs eyeball to eyeball with the

WILLIAM M. ARKIN is a fellow of the Institute for Policy Studies in Washington, D.C., a contributing editor of the Bulletin of the Atomic Scientists, and co-editor of the Nuclear Weapons Databook series. He has written numerous books and articles on military affairs and the naval arms race, including *The Nuclear Arms Race at Sea*, published jointly by the Institute for Policy Studies and Greenpeace.



Key:

CIWS = close-in warfare support
SAM = surface-to-air missile

DD = destroyer

DDG = guided-missile destroyer

LAMPS = light airborne multipurpose

Shrike/Harm = anti-radiation missile

Harpoon = medium-range missile

LCAC = landing craft air cushion

AV-8B = Harrier attack airc

CH 53 = cargo helicop

Carrier-based weapons:

Sea Sparrow close-in wa

F-14 and F/A-18 fighters

F/A-18, A-7, and A-6 attack aircraft

E-2 airborne early-wa

EA-6 jammer aircraft
KA-6 tanker aircraft



In 1985 congressional hearings on the Maritime Strategy and a 600-ship U.S. Navy, Adm. James Watkins used this diagram to illustrate "what naval warfare is about in the modern age." According to Watkins, "All of these forces are synergistically combined to provide a tremendous capability to deter, and to win if deterrence fails."

NUCLEAR FORCES AT SEA

WEAPONS

	U.S.	Soviet	U.K., France and China	Total
Strategic warheads	5,472	3,378	359	9,209
Nonstrategic warheads				
Cruise missiles	150	500	0	650
Aircraft bombs	1,450	0	216	1,666
Antisubmarine weapons	1,760	1,400	140	3,300
Antiair weapons	300	260	0	560
Naval artillery	0	100	0	100
Coastal missiles	0	100	0	100
Total nonstrategic weapons	3,660	2,360	356	6,376
Total weapons	9,132	5,738	715	15,585



In 1984, the Reagan administration stated that a naval arms race "did not and does not exist." However, the superpower navies

SUBMARINES AND SHIPS

	U.S.	Soviet	U.K., France and China	Total
Submarines				
Ballistic missile	35	76	14	125
Cruise missile	0	60	0	60
Attack	61	202	0	263
Total submarines	96	338	14	448
Ships				
Aircraft carriers	19	6	5	30
Battleships	3	0	0	3
Cruisers	37	34	0	71
Destroyers	64	52	12	128
Frigates	65	119	12	196
Patrol combatants	0	65	0	65
Total ships	188	276	29	493
Total submarines and ships	284	614	43	941

Soviets daily, either in the air, on the surface, or under the water."

The U.S. Navy, Lehman told Congress, is "spending more time at sea than it had even averaged in the Second World War." The Soviet and Allied navies have conducted larger and larger operations and maneuvers and shown a new belligerency. And the strategy has led the nuclear powers to demonstrate their willingness to use naval force in many new areas, including Libya, Grenada, Lebanon, and the Persian Gulf.

Creating Crisis and Escalation

Since the United States embarked on the Maritime Strategy, many observers have charged that it could escalate a crisis in ways that political leaders might be unable to control. Thus, the Maritime Strategy would drive policy rather than the other way around. "We now live in the worst of all possible worlds," MIT political scientist Barry Posen has written. "We plan potentially escalatory conventional operations,

now contain about 15,000 nuclear weapons. In the past decade, they have added almost 3,000 nuclear warheads to their naval arsenals.

but we do not seem to understand their implications."

Under the Maritime Strategy, the first phase of a crisis is called both "deterrence" and "transition to war." That the two terms are seen as synonymous is one cause for concern. A more important question is how long the "transition" lasts and how military and political decisions would be made during this crucial period. The doctrine is dangerously ambiguous on whether the intention is to move only after war has broken out or in anticipation of hostilities, but either way, speed is clearly essential.

If such rapid movements do not widen a conflict, the offensive objectives of the Maritime Strategy once ships and submarines are positioned for battle certainly will. Consider the intention to control choke points near the Soviet Union. A strategy that incorporates destroying strategic nuclear forces at sea with attacks on Soviet homeland bases and landings by the U.S. Marine Corps begins to resemble an attempt to win an unlimited war. Taking the first steps under the Maritime Strategy during a crisis

T*aking the first steps under the
Maritime Strategy during a crisis could send false signals
that the United States was beginning a
disarming general war.*

could send false signals that the United States was preparing a disarming general war. And since forward operations would occur close to Soviet territory, the Soviets would commit more than their navy to the operations around its periphery. The result would be a high-intensity confrontation involving sea and land forces, taking place in several theaters simultaneously. All of this could be the result of naval movements and activities that take on their own momentum, quite separate from what was originally the main focus of a conflict.

The Maritime Strategy is also the most likely avenue for escalation all the way to nuclear war. Although the Navy seems to think that its plans could be implemented within the limits of a conventional confrontation, the strategy's rapid-moving scenarios and uncertain objectives threaten to create a broader conflict. In addition, the routine presence of nuclear weapons in the oceans and their integration into U.S. and Soviet navies increases the likelihood that nuclear weapons would be employed, either by design or by accident, in the course of a high-intensity conventional war. Objectives like the invasion of the Soviet Union or a disarming first strike against Soviet strategic submarines could easily precipitate the use of nuclear weapons.

Moreover, the Maritime Strategy introduces the possibility that the U.S. Navy will launch nuclear strikes in response to conventional attacks. There appears to be an implicit assumption that nuclear weapons at sea have military roles that simply augment those of conventional weapons. Caspar Weinberger wrote in his 1987 report to Congress that "in addition to deterring Soviet first use of similar nuclear weapons at sea, U.S. nuclear antiair and anti-submarine weapons provide unique capabilities that serve as a back-up for our conventional systems." This "first-use" strategy is essentially a statement of an intent to escalate to nuclear weapons if conventional weapons do not destroy prospective targets.

The Navy believes that the use of nuclear weapons at sea, unlike land-based ones, would not necessarily create an all-out war. On the contrary, sea-based weapons are a *more* likely spark for a nuclear war because the Navy operates outside political factors that constrain land-based military forces. For example, Navy spokesmen point out that if Spain, Greece, or the Philippines bans U.S. bases from their soil, aircraft carriers could take up the slack, independent of land-based politics. The same thinking

goes into theories about physically controlling nuclear weapons aboard ships: they do not have the same locks that land-based weapons do because the Navy is accustomed to greater autonomy.

Finally, because oceans are borderless, current naval practices and strategies threaten international peace in a way that land-based military activities do not. Operations on the high seas carry a much greater potential for direct confrontation, misunderstandings, accidents, incidents, and crises.

The Arms Race at Sea

The U.S. government has been adamant in denying that the Maritime Strategy's sweeping goals are contributing to a perilous naval arms race. In 1984, the United States was the only major country to vote against a U.N. resolution to conduct an expert study of the buildup. The reason, the Reagan administration stated, was that a naval arms race "did not and does not exist."

Nevertheless, the race does exist, and it has accelerated since 1980. About 15,000 nuclear weapons are in the navies of the two superpowers (see the table on page 58). The five nuclear powers possess more than 9,200 submarine-launched ballistic-missile warheads, strategic nuclear weapons that are intended either to attack land targets or to destroy ships, submarines, and aircraft. More than 1,000 ships and submarines, including 75 percent of those in the U.S. inventory and virtually all major Soviet warships, are prepared for nuclear combat.

In the past decade, the two superpowers have added almost 3,000 nuclear warheads to their naval arsenals, deploying new ballistic missiles, cruise missiles, torpedoes, and bombs. The United States has the largest number of naval nuclear weapons, with some 9,100 aboard 284 ships and submarines. The Soviet Navy has about 5,700 naval nuclear warheads on 614 ships and submarines.

The SALT treaties placed limits on ballistic-missile submarines and their weapons but have had no effect on the non-strategic naval arms race. Nor did they forestall the 2,000-warhead increase in strategic submarine forces since 1979 or the move toward counterforce capabilities—the ability to strike at hardened nuclear forces—at sea. In 1974, the superpowers concluded an agreement on preventing incidents at sea, but it has done little to curtail provocative maneuvers.



In peacetime, the nuclear navies face each other continuously. For example, the United States conducts aggressive "freedom of navigation" maneuvers that are regular occasions for superpower confrontations. For no obvious reason, routine exercises in the Baltic and Black seas have widened. In March 1986, a U.S. cruiser and destroyer sailed to within six nautical miles of the Crimean coast. The Soviet Union protested, but the White House stated the vessels were testing the "right of innocent passage."

Larger naval exercises in the Atlantic and Pacific have drawn military reactions. During August and September 1985, NATO held Ocean Safari 85—its largest exercise ever—in the Norwegian Sea. The Soviets responded with sorties by 19 ships and submarines and 96 aircraft. Extensive Soviet submarine activity accompanied Teamwork 84 in the northern Atlantic, which included a Marine Corps amphibious landing in Norway—"almost on the border of the Soviet Union," according to the U.S. Navy. From October to December 1985, the United States conducted Fleetex 85, its largest peacetime fleet exercise since the Second World War. The exercise included five aircraft battle groups, two of which approached to within 50 miles of the Soviet city of Vladivostok. In response, the Soviets conducted over 100 fighter, bomber, and reconnaissance flights and put their surface warships on alert.

One would think the U.S. Navy was deliberately trying to goad the Soviets. In fact, Adm. Watkins testified in 1984, "the Soviets actually act as our target forces, our orange forces, as we call them.

They provide very effective exercise services to our forces because we can really see what we are up against."

No doubt navies do learn much from war games, but the result could be disastrous if a real confrontation arose or one nuclear navy miscalculated the intentions of the other. On March 21, 1984, while on routine night maneuvers in the annual NATO Team Spirit exercise, the aircraft carrier *USS Kitty Hawk* collided with a Soviet nuclear-powered submarine 150 miles east of the Korean peninsula. The *Kitty Hawk* ruptured a fuel tank, and the submarine had to be towed back to base. According to Lehman, about 40 of these "potentially dangerous incidents" occurred during 1982; there is no evidence that the number has declined.

Confrontation in the Persian Gulf

The Navy's new aggressiveness and higher profile are not only being used in the U.S.-Soviet contest. They are also becoming regular tools in Third-World intervention. Recent naval operations in the Persian Gulf and Indian Ocean have dramatically illustrated some of the dangers of the naval arms race.

Less than a decade ago, the Indian Ocean was so peaceful that the United States and the Soviet Union began negotiations to declare it a "zone of peace." But in response to a border conflict between the Yemens in 1979, the United States began deploying a carrier battle group in the Indian Ocean. Following the overthrow of the shah of Iran and the Soviet



Under the "revised" Maritime Strategy, provocative maneuvers and dangerous incidents continue. On February 12, 1988, a Soviet light frigate sideswiped the port quarter of the USS *Caron* nine miles from

the Crimean coast in the Black Sea. According to the Defense Department, "The U.S. Navy destroyer was exercising the right of free passage through the Soviet-claimed 12-mile territorial waters."

invasion of Afghanistan, the deployment rose to two carriers. With the Iran-Iraq war, the operations reached a wartime level, with as many as 30 U.S. combat ships in the area.

The first of three major incidents erupted in May 1987, when two Iraqi Exocet missiles struck the USS *Stark*, killing 37 men. One year later, the frigate USS *Samuel B. Roberts* struck a mine, injuring 10 sailors, three seriously. Within a week, the United States called on its 21 warships in the area. They destroyed one oil platform and damaged another, sank one high-speed Iranian frigate and disabled another, sank a missile-carrying attack craft and several smaller patrol boats, and shot down at least one fighter.

Such was the backdrop for the July 3, 1988, incident when the USS *Vincennes* shot down Iran Air flight 655, killing 290 civilians. Investigators later blamed an inexperienced crew that misinterpreted information from the AEGIS air-defense system and misread schedules indicating that a commercial airliner was due in the area. Working under the stress of combat, the crew mistook the Iranian Airbus for an F-14 fighter. The skipper, confident that his equipment was infallible, gave the order to fire.

In fact, the ship's electronic sensors were not to blame for the disaster. Working under constant fear of attack and cruising close to potential attackers, commanders were under constant stress, with only minutes to make life-or-death decisions. That a bad decision was taken in the field, in a crisis, should not be surprising.

A "Revised" Strategy

Luckily, the opponent this time wasn't the Soviet Union, and the occasion wasn't a crisis that could end in superpower nuclear war. But the shock of three separate U.S. naval vessels engaging in combat has fueled doubts about the naval buildup and the Maritime Strategy. Further, amidst weapons-procurement scandals and decreased public support for military spending, the Defense Department has stalled the expansion to a 600-ship Navy.

Just as talk early in the Reagan administration of strategic superiority and winning a nuclear war alarmed the public, so has the degree of naval belligerence. Today's naval leadership is not nearly as visible as were Lehman and Webb, and Western naval spokesmen have tried to downplay the Maritime Strategy's controversial aspects. The Navy appears to have retreated on other fronts as well: over the past year, shipbuilding and weapons purchases have been drastically reduced, and the level of provocative maneuvers in the northern Atlantic and Pacific oceans has declined.

The Soviets have also reduced their naval activity. According to the Office of Naval Intelligence, "Soviet naval operations worldwide declined significantly in 1986 compared to the operational tempo during 1983-1985.... The Soviet Navy conducted its major exercises in waters close to the Soviet mainland—also a departure from exercises in recent years." In addition, the Soviets have recently made significant reductions in their naval operations in the

***T*he time is ripe for the
United States to look beyond the Maritime Strategy
and engage in serious efforts at
naval arms control.**

Indian Ocean.

Nevertheless, despite all the criticism heaped on the Navy, the service has only revised—not abandoned—the Maritime Strategy. None of its components have been changed in actual war plans. U.S. policy still includes aggressive operations close to the Soviet Union in peacetime, increased use of land-based facilities to support offensive naval operations, and rapid deployments of attack and ballistic-missile submarines. Plans still call for the movement of forces during the “pre-conflict” period, including the deployment of nuclear-powered attack submarines deep in Soviet “sea control areas” and “home waters.” Wartime strategies still include strikes against naval bases inside the Soviet Union, the destruction of Soviet strategic nuclear ballistic-missile submarines, and the first use of sea-based nuclear weapons.

Warships, submarines, and surveillance aircraft continue to operate in dangerous proximity to opposing forces. Under the “revised” strategy, provocative maneuvers and dangerous incidents continue:

- In January 1987, the Marines conducted their first amphibious landing at Shemya Island in the Aleutians since the Second World War.
- In May 1987, the cruiser USS *Arkansas* entered Avacha Bay near Petropavlovsk, violating Soviet territorial waters.
- In September 1987—during Ocean Safari 87, involving over 150 ships—U.S. aircraft carriers operated even farther north near the Soviet Union than they had in Teamwork 84. Navy commandos on land simulated directing air attacks on “enemy” territory.
- On February 12, 1988, the cruiser USS *Yorktown* and the destroyer USS *Caron* were sideswiped by two Soviet frigates nine miles from the Crimean coast in the Black Sea. It was these same two U.S. vessels that had drawn Soviet protests a year earlier by approaching the Crimean coast.

Rather than retreat from the Maritime Strategy, the Navy has shifted to less visible submarine forays and has increased attack submarine patrols in the north Pacific and Atlantic. In August 1986, Pacific Fleet Commander Adm. James A. Lyons, Jr., described “a major shift” in U.S. military operations, including regular carrier deployments in the Bering Sea and off Alaska. Although the polar ice cap is practically impassable to surface ships, the Arctic is

increasingly used for submarine operations, including regular Soviet strategic submarine patrols and attack submarine operations. In February 1987, Adm. Carlisle Trost, Watkins’s successor as chief of naval operations, revealed that U.S. “submarines are routinely deployed into Arctic waters where they might be expected to carry out wartime campaigns and battle plans in support of the Maritime Strategy.” To support this heightened activity, the U.S. Navy has quietly built a maintenance facility on Adak Island in the Aleutians to conduct minor repairs and refits. This focus on submarine operations and the move north are part of better positioning for implementing the Maritime Strategy. Covert submarines will bear the brunt of the U.S. plans to bottle up the Soviet Navy early in a conflict.

Finally, the greater use of naval forces in the Third World is not a side effect of the Maritime Strategy but rather increasingly central to it. While Maritime Strategy asserts that U.S. superiority is necessary vis-à-vis the Soviet Union, achieving this objective is an expensive proposition. The Navy sees its own stock rising in a more competitive budgetary fight as it is called upon to conduct Third-World military operations that the other services are incapable of.

Bringing Peace to the Oceans

The time is ripe for the United States to look beyond the Maritime Strategy and engage in serious efforts at naval arms control. Many other nations have begun pressuring the superpowers to do so. At the behest of such non-aligned nations as Sweden and Indonesia, the just-concluded United Nations Third Special Session on Disarmament took up the issue of the naval arms race. Debate about naval issues, including nuclear weapons on visiting U.S. ships, is taking place in Denmark, Greece, Spain, Japan, the Philippines, Sweden, Canada, and the South Pacific nations.

That global outcry has been exacerbated by the Navy’s penchant for secrecy, including the U.S. policy of neither confirming nor denying the presence of nuclear weapons on naval vessels. Already that policy has led to a break in defense relations with New Zealand and has created severe friction with Denmark. Numerous other U.S. allies are strengthening their non-nuclear policies, and more than half



Advocates of the Maritime Strategy say that sea-based nuclear weapons would be immune from foreign political events—like these Filipino protests—that might constrain land-based weapons. However, debate about naval issues, including nuclear weapons on visiting U.S. ships, is occurring in the Philippines as well as in Denmark, Greece, Spain, and elsewhere. The Navy's nuclear policies are straining relations with several U.S. allies.

the members of NATO now restrict the deployment of nuclear weapons on their soil.

For its part, the Soviet Union has consistently proposed naval restraints since 1980. At the UN Second Special Session on Disarmament in 1982, the Soviets recommended a number of naval limitations, such as confining the cruises of missile submarines, limiting new submarine missiles, renouncing sea-based long-range cruise missiles, and instituting regional measures in the Mediterranean and the Persian Gulf. In November 1986, Gorbachev stated the Soviet Union's readiness "to start talks on the reduction of the activity of naval forces in the Pacific," emphasizing nuclear-armed ships.

Unfortunately, the U.S. government has rejected any controls on naval armaments or operations. Whether or not the Soviets are sincere, the West's reluctance to take the issue seriously is a major impediment to progress. Far from considering any fundamental changes, the Navy doesn't even seem to take the subject of arms control seriously. Responding to my Freedom of Information Act inquiry for studies on controlling non-strategic naval nuclear forces, the Navy stated in 1987, "Inquiry of the Office of the Chief of Naval Operations has failed to disclose any studies responsive to your request." Only in 1988 did the Navy start to take arms control seriously, but just to the extent of finding all the arguments against it.

The priority for international security must be to eliminate the maritime weapons, operations, and strategies that could contribute to the unintentional outbreak of a conflict or the escalation of a crisis. This comprehensive approach may not be arms control in the traditional sense of weapons limits and technical verification. Rather, it is a concept saying that activities or strategies that are potentially de-

stabilizing should be stopped on their own demerits. As a first step, the superpowers should restrict the peacetime operations of nuclear navies and the routine carrying of nuclear weapons on naval vessels; they should ban naval nuclear weapons such as long-range sea-launched cruise missiles and carrier-based attack aircraft since the navies themselves do not believe that they serve a role in deterring war.

Further steps might include:

- Agreeing to refrain from dangerous maneuvers and harassment at sea,
- Notifying other nations in advance of naval exercises,
- Instituting strict codes of conduct for submarines and anti-submarine warfare forces,
- Restricting naval forces from areas remote from home ports or close to other nations, and
- Refraining from establishing new military bases abroad.

Implementing all these possible measures would be unlikely outside a broader framework of East-West coexistence. But some of them should be implemented, even unilaterally, if for no other reason than that they eliminate potential points of conflict and misunderstanding between the superpowers.

In the 1980s, the arms race at sea has received some of the attention previously reserved for the arms race on land. That attention is appropriate. At a time when much arms-control effort is focusing on avoiding accidental nuclear war, the Maritime Strategy cannot be left to an intransigent naval bureaucracy. The biggest danger is that the Navy's provocative activity and destabilizing contingency plans continue largely in secret. An appreciation of the full dangers of the Maritime Strategy may only emerge during a crisis, when it is too late to control fast-breaking events. ■

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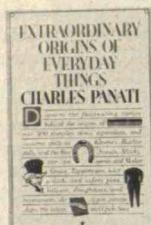
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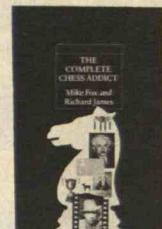
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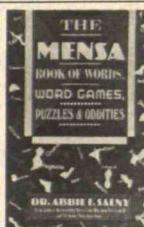
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Reviews

THE MEDIA

The Return of the Shuttle Syndrome?

BY FRED JEROME

In the wake of the *Challenger* disaster, the press went through a great deal of soul-searching over its failure to report on NASA's troubles during the years before the accident. Several veteran space reporters were criticized for having let themselves be co-opted by the space agency. Indeed, most of the post-*Challenger* investigative reporting that brought to light the internal problems of NASA and Morton Thiokol was done by journalists newly assigned to the story, as most old hands found their usual sources had—or had been—clammed up.

At a 1986 AAAS symposium on "Media Coverage of the Shuttle Disaster," the *Atlantic's* Gregg Easterbrook, who had written an article years earlier pointing to the likelihood of an accident eerily similar to the one that actually took place, maintained that "most of the press will only criticize a defense or space-related decision after it has turned into a fiasco. I fear the same sequence of events happening again, a replay of the shuttle syndrome."

Now that *Discovery* has been safely launched, it's time to consider whether the press has learned the lessons of the *Challenger* disaster. But for a few important exceptions, the media has unfortunately proved Easterbrook right. *Discovery's* flight brought a replay of the shuttle syndrome.

Star-Spangled Cheerleading

After *Challenger's* failure, it's understandable that most people would be rooting for an unequivocal success. However, much of the press reporting did little more than play on that widespread sentiment, sometimes going to ridiculous lengths.

Nearly a month before the September 29 launch, *New York Daily News* veteran space reporter Alton Slagle was already proclaiming that "Discovery's flight will be a reaffirmation to the people of the United States and the watching world of what this nation can do when tested to overcome the most dire adversity. And it will be . . . a brave memorial to the seven



who died in the fiery crash of the *Challenger*."

By the launch date, shuttle coverage had become a four-day spectacle of star-spangled cheerleading, complete with front-page full-color photos, banner headlines, and TV specials. "The Magic Is Back," "The Sounds of Hearts Rising," and "Cargo of the Nation's Dreams," read typical headlines. TV reports featured spectacular lift-off shots shown over and over again, patriotic profiles of astronauts, wide-eyed schoolchildren, T-shirted tourists "proud to be American"—and, of course, politicians' speeches, including the carefully staged campaign event of George Bush welcoming the *Discovery* astronauts home.

But the shuttle story, like most science and technology stories, is far more than a single event. It consists of a complex web of political, economic, and technical decisions. In the midst of all the flag-waving over the launch itself, many journalists missed key aspects of the story.

Take the all-important question of the shuttle's safety. After the *Discovery* launch, a newsman on Fox television announced that the shuttle was "mechanically as safe as humanly possible. The bird's perfect." But the real safety question in the shuttle program is reusability: How will the spaceship and booster rockets hold up to the accumulation of stresses and strains over many launches and land-

ings? And will safety checks and reviews by Morton Thiokol, NASA, and outside observers be as meticulous in the future as they were for the highly visible *Discovery* flight, or will commercial pressures and declining media coverage lead to reduced vigilance?

CBS Evening News executive director Tom Bettag told me that "the real problem is not in covering *Discovery*—we had lots of monitoring on that one. But how is a journalist going to interest his editor in a safety story on the fifth or sixth shuttle flight? The editor's going to say, 'Oh God, I don't want to hear about that again.'"

And even for the *Discovery* flight, the media's performance on the safety issue is far from reassuring. During the summer, shuttle preparations seemed to hit a new snag almost weekly—damaged booster joints, fuel-line leaks, and the like. But most journalists did little more than dutifully quote NASA officials. At an August 4 press conference, for example, launch director Robert Sieck reassured the media that a reported leak in the fuel line wasn't important because "it's a very slight leak." No one bothered to ask Sieck exactly what "very slight" might mean in this context or, given all the heat and pressure of a shuttle launch, precisely how much of a leak it would take to cause a serious problem.

Even when the press did cover the shuttle's ongoing problems, journalists rarely got into the technical details or explained the significance of what they were reporting. For example, a September 22 article in *The Wall Street Journal* reported that Morton Thiokol had found "more than 1,000 possible problems during the redesign of the booster rockets," adding, as the only comment reported, a company spokesperson's assertion that most were "unavoidable risks."

Troubling Questions

But beneath the media tidal wave of wows, an undercurrent of doubt did emerge, suggesting that, at least in some respects, the *Challenger* disaster changed space reporting for the better.

From Cape Canaveral, AP national editor Mike Silverman, who had covered nine earlier shuttle launches, told me that the mood among reporters there "will never again be uncritical towards NASA the way it was before *Challenger*." Indeed, at the press conference immediately fol-

Some leading journalists used the shuttle launch to raise questions about the entire space program.

lowing the lift-off, reporters pressed NASA officials with heated questions on, among other matters, why the previously announced weather restrictions on the launch had been waived at the last minute.

What's more, a number of leading newspaper and network journalists used *Discovery's* launch as an occasion to raise critical questions about the shuttle's future and that of the entire space program.

In a probing article a few days before the launch, *San Francisco Chronicle* science editor David Perlman wrote that the civilian space program has become "increasingly dominated by America's military space projects." Money talks, and as the article reported, the Pentagon's annual space budget, once less than half that of NASA's, has now reached \$17.5 billion, double what the space agency spends. Perlman, one of the country's top science writers, added that because of rising safety concerns, "Pentagon officials plan to rely

less and less on the shuttle to carry the military's future payloads into space, returning to the use of . . . expendable launch vehicles."

On the very night of the launch, NBC-TV science correspondent Bob Bazell told millions of viewers that there is "disagreement among scientists" about the plan for a manned space station. Many scientists, he explained, believe "the unmanned *Voyager* missions brought us far more information than the manned flights, and for less money."

In a similar vein, the lead editorial in the *New York Times* that morning stated that "space scientists would love to free their projects from the shuttle's delays and inflexibility." And only nine days later, the *Times* attacked NASA's manned space program even more bluntly, calling it "a dangerous illusion." The paper's October 8 lead editorial declared that "almost all the practical advantages of space come

from unmanned rockets and automatic spacecraft," and warned that if NASA continues on its current course, "despite the \$2.5 billion spent on safety improvements, there will be another space shuttle accident sooner or later."

Unfortunately, most Americans probably missed or ignored these sobering reports. Usually, they were buried on inside pages while front-page headlines were trumpeting glory. Too bad, for while the questions they raise are controversial, they are as much the real shuttle story as the national exhilaration over *Discovery's* success. ■

FRED JEROME is executive vice-president of the Scientists' Institute for Public Information. This is the first of a series of columns on how the media cover science and technology.

BOOKS

Ideology and Disease

Hidden Arguments
by Sylvia Noble Tesh
Rutgers University Press, \$30.00/\$15.00

BY DEBORAH STONE

Scientists are drawn into debates about occupational hazards, environmental toxins, drugs, or diet chiefly as arbiters of the grand question of causation. The more we learn how substances and behavior give rise to illness and injury, the more these components of modern life become issues in public-health policy. The working assumption of most scientists, the officials who call upon them, and the general public is that such causal links can be determined objectively, and that social or political values distort the rational search for the truth.

In *Hidden Arguments: Political Ideology and Disease Prevention*, Sylvia Tesh challenges this conventional wisdom. She argues that the search for causes is an inherently political process. Every theory of disease causation entails some presuppo-



sitions about human nature, about the proper organization of society, and about what qualifies as legitimate evidence in scientific inquiry. Both science and public-health policy would benefit, she believes, if these presuppositions were acknowledged rather than dismissed as the pleadings of "special interests" outside the scientific community.

Tesh does not claim that there are no demonstrable causal mechanisms of disease. Rather, she believes that no specific policy for prevention necessarily follows from any particular causal mechanism. Instead, policies are determined by a host of factors such as available technology, human imagination, and values that define acceptable social practice.

The problem is that people often evaluate a theory of causation according to what they assume or hope its implications for prevention may be. Since specific preventive measures always involve a redistribution of costs and benefits, policies of disease prevention become hostage to conflicting political interests.

For instance, during the nineteenth century, physicians developed the theory that disease was spread by specific agents such as bacteria. Originally known as "contagionism," the theory apparently implied that the best way to prevent a disease was to quarantine its carriers. Because this led to a variety of proposals for closing ports and restricting travel, contagionism seemed to threaten international trade, which was the lifeblood of the commercial classes and essential to British and U.S. economic development.

Members of economic elites—including many physicians—attacked the theory. They contended that government should

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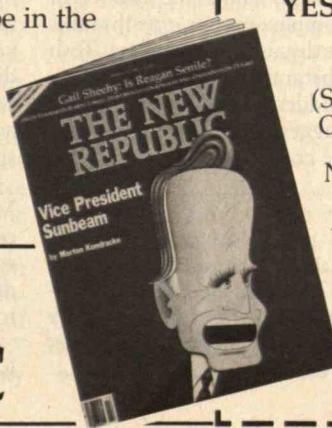
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THE NEW REPUBLIC

THE MINDS THAT MATTER

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Political values should be made explicit in disease-prevention policies.

not interfere with commerce, that quarantine was useless, and that preventive measures would cause economic stagnation. But after vaccines and antibiotics were invented in the mid-twentieth century, the same theory appeared less economically disruptive. In effect, contagionism became socially acceptable.

Tesh's ideas provide valuable insight into contemporary conflicts over preventive policies. Business interests now challenge theories of causation that point to the central role of environmental and occupational exposure to toxic substances. Corporate leaders, much like critics of contagionism a century ago, argue that environmental safeguards are a costly and inefficient impediment to productivity and entrepreneurial decision making. They champion lifestyle theories, which call for changes in individual behavior, and, occasionally, genetic theories, which call for screening individuals and isolating "hypersusceptible workers." Such policies are less expensive than actually modifying production processes to reduce exposure.

Disguising Political Disputes

In arguing that political values should be made explicit in policymaking about disease prevention, Tesh supplies a fascinating example of what happens when they are not—the 1981 strike of the Professional Air Traffic Controllers Organization (PATCO).

PATCO's conflict with the Federal Aviation Administration capped years of dissension over poor working conditions and authoritarian management. Unlike private-sector and some public-sector employees, the air traffic controllers did not have the legal right to strike, so PATCO tried to define the issue as one of health and safety, emphasizing that they faced high levels of "stress" and implying that this undermined their ability to handle air traffic.

However, in subsuming the important subjective concerns of the controllers under the label of stress, PATCO unintentionally empowered physicians and epidemiologists to arbitrate the dispute. These medical experts reduced the complexities of the controllers' situation to empirically measurable indicators such as hormone levels, blood pressure, heart rate, and individual psychological attitudes. Tesh maintains that such studies were virtually guaranteed to ignore what really

mattered to PATCO members—their relation to their bosses, their constant dread of disaster, their perceived burdens of moral responsibility, and their sense that authoritarian management was violating their professionalism. The ultimate effect was to frame the problem as a matter of individual personality rather than collective working conditions.

A Diseased Social Structure?

The ultimate object of Tesh's criticism is the approach dominant in public-health circles today. In this view, all kinds of factors—including psychological disposition, personal behavior, genetic makeup, environmental substances, work, social situation, and even national and international economic systems—are woven together in a so-called web of causation. Such an eclectic theory, says Tesh, explains everything and nothing. Because it provides no hierarchy of importance, it offers absolutely no guidance about where to start preventing disease.

Tesh's alternative is to locate the "fundamental cause" of disease in social structure, by which she apparently means the economic and political system as a whole, with its vast inequalities of wealth, living and working conditions, and political influence. She asks scientists to look carefully at how causal theories differentially blame, burden, help, and privilege people of various genders, races, classes, and nationalities, and she urges decision makers to choose prevention policies that promote equality.

However, "social structure" is no more specific a designation than "web of causation." And even Tesh's own ultimate value of "equality" does not provide a firm criterion by which to judge prevention programs. Adjudicating the competing claims put forward under the banner of equality is a complex matter, one that this book does not discuss. Nonetheless, Tesh has made a substantial contribution by revealing how hidden values shape medical debates and suggesting how an honest inquiry might be conducted.

DEBORAH STONE is the David R. Pockross Professor of Law and Social Policy at the Heller School of Social Welfare, Brandeis University.



BOOKS

Compensatory Technologies

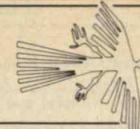
Engineering Disability
by Sandra J. Tanenbaum
Temple University Press, \$29.95

BY FRANK G. BOWE

Actions of God and man create disabilities, but public policy determines how the compensatory burden will fall," writes Sandra Tanenbaum in *Engineering Disability: Public Policy and Compensatory Technology*. We as a nation have yet to reach a consensus about how to handle that burden. Instead, we have created a patchwork quilt of government programs and private health insurance policies that offers real support to veterans disabled in combat, some help to disabled civilians who neither work nor seek employment, and little or nothing to adults who want to continue working despite a disability.

Tanenbaum, a policy analyst for Ohio Medicaid, does a good job describing the contradictions of this cost-reimbursement system gone haywire. However, she offers disappointingly few concrete suggestions to help us actually develop better policies.

According to Tanenbaum, a "disability is a loss—of function and correspondingly



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FRANK G. BOWE is the author of *Changing the Rules and Personal Computers and Special Needs, among other books. His article "Why Seniors Don't Use Technology" appeared in the August-September 1988 issue of Technology Review.*

of mobility, employability, and the like." *Engineering Disability* explores in detail one mechanism for addressing such a loss—"compensatory technologies" that replace lost functions.

Tanenbaum's chief case study is the development of a sophisticated replacement limb for upper-arm amputees. The "Boston Elbow" is a myoelectric artificial arm that detects and responds to electromyographic (EMG) signals on the skin. This allows users to flex and extend the prosthesis much as they once did their arm and hand to perform lifting, manipulating, and related functions.

It is something of an accident that we have a Boston Elbow at all. In 1961, MIT mathematician Norbert Wiener, who had suggested applying cybernetic theory to prostheses, was hospitalized after breaking his hip. His surgeon, Melvin Glimcher, was also the head of the amputee clinic at Liberty Mutual Insurance Co. Through Wiener, Glimcher met MIT mechanical engineer Robert Mann who, funded by Liberty Mutual, applied Wiener's biofeedback ideas to develop an above-elbow prosthesis.

The Boston Elbow is a "successful" technology, in the sense that it works. But at a cost of \$12,500, including fitting and training, it is expensive. And of the mere 200 or so in existence, only 100 have actually been fitted—a drop in the bucket for the 53,000 above-elbow amputees in the United States.

Tanenbaum wonders whether such high-tech devices are appropriate for the average amputee. They are expensive, their useful life span seldom exceeds five years, and repair is difficult and costly.

Moreover, she points out that there are other ways to address a patient's disability in addition to providing devices like the Boston Elbow. Retraining can teach an amputee to function despite the loss of a limb; many people find they can do surprisingly well with just one arm and hand. Environmental modification can adapt the home, the work space, and other frequently used areas to the unique needs of the amputee. Finally, cash compensation—from an employer, health insurance carrier, or government—can defray some of the financial costs of loss of function.

Tanenbaum argues that "choosing an environmental strategy over a person-focused one generally lowers the cost of compensation to people with disabilities." However, "it may raise the cost to society

as a whole." For example, retrofitting the New York subway system to make it accessible to wheelchair users would cost tens of billions of dollars. Tanenbaum is concerned that, by making disability-related spending widely visible, environmental modification can fuel resentment on the part of able-bodied taxpayers. She relates the comment of disabled sociologist Irving Zola that "in its enthusiasm for non-environmental (read: inexpensive) measures, society may decide to shrink wheelchair users rather than widen doorways."

But this conflates two separate issues. The first is the relative merits of environmental changes versus personal aids. The two approaches to compensating disability are not mutually exclusive. Clearly, some disabled people need both.

The second is the question of who should pay, disabled individuals or society as a whole—whatever specific compensatory mechanisms prove most effective in a particular case. While Tanenbaum clearly favors social support for disability compensation, she never formulates a compelling set of policies to bring it about.

One way to do so would have been to take a long hard look at "handicap aids" programs and similar device distribution systems in countries such as Denmark, Sweden, and the Netherlands. These European nations get devices into the hands of those who need them, at little or no cost to disabled people. They also invest considerable resources in the modification of the environment. Analyzing the benefits and costs of the far more comprehensive disability policies of such countries would be an important first step toward resolving the inequalities and gaps in our own system.

If Tanenbaum had more clearly laid out the policy choices we as a nation face in the 1990s, she might have provided a new point of departure on disability policy. But even as it is, *Engineering Disability* at least draws our attention to a long-standing social problem. ■

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Dialing Up Space Experiments

While biomedical engineer Byron K. Lichtenberg was conducting a physics experiment aboard the space shuttle in 1983, he ran into a situation he wasn't expecting. All he could do was call the ground and ask for more information from the scientists heading up the experiment. The procedure was time-consuming and wouldn't even have been feasible if the researchers hadn't already traveled from their universities in Spain, Italy, and Holland to Johnson Space Center.

Now Lichtenberg, along with fellow MIT researcher Charles M. Oman, is conducting tests to make the links between ground- and space-based scientists simpler and more efficient. Working under a NASA contract to set up "telescience" projects, Oman and Lichtenberg are examining methods to send information between space and many locations on the ground. Instead of having to work out of Johnson Space Center, for example, future scientists might be able to contact astronauts from their university offices. And Lichtenberg and Oman are determining how much power is needed for astronauts and ground-based scientists to send information through video and data links as well as voice hookups.

With telescience connections, ground-based scientists could coach astronauts, who essentially would serve as lab technicians. "We aren't going to have hundreds of experimenters up in space, not in the near future," Lichtenberg says. "But we'd still like the experiments to be as productive as possible."



In the Pacific Ocean, 180 miles west of Vancouver, a sensitive camera photographed light emitted from a hot-water vent 7,200 feet below the surface. Cindy Lee Van Dover, a graduate student in the joint MIT-Woods Hole Oceanographic Institution program, discovered this light source with colleagues after finding that eyeless shrimp living near thermal vents have light receptors. Van Dover postulates that the light source is thermal radiation and speculates that microorganisms in the vicinity might use the light for photosynthesis.

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The Disappearing Boxcar

The deregulation of the U.S. rail industry between 1978 and 1980 resulted in a sharp drop in employment as companies took actions such as abandoning less profitable lines. The net operating income did increase from 1983 to 1985, but the industry could have retained more jobs—and more business—if labor contracts had kept pace with the technological innovation of the past 40 years, says Carl D. Martland, a principal research associate in MIT's Department of Civil Engineering.

In a recent paper, Martland blames

management and government as well as unions for not having resolved issues such as anachronistic pay scales. For example, in the days of the steam engine, when the maximum distance covered during an eight-hour shift was about 100 miles, "train crews received additional pay if they worked extra time or traveled extra miles," Martland explains. Although today's diesel-engine freight trains can travel several hundred miles in less than eight hours, the pay schedules have not changed, so in an eight-hour shift crews can get paid for several days of work.

Since deregulation, management has cut labor costs by concentrating on shipping bulk loads such as automobiles, which don't require as much labor as boxcar loads do. The number of boxcar loads has declined dramatically from the late 1970s, he says.

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**Can Computers
Forestall War?**

Examining the factors that have led to recent regional wars could help prevent politically touchy situations from escalating into full-scale military clashes. This premise underlies CASCON III, a personal-computer program developed by MIT political science professor Lincoln P. Bloomfield and research scholar Allen Moulton.

The program includes 540 factors involved in 66 conflicts that followed World War II. The idea is to decide which of these factors are relevant in current situations and use the information to keep trouble from worsening.

Originally developed for a mainframe computer in the early 1970s, CASCON III has been reconfigured for personal computers so that more people can use it. Both the State Department and United Nations have expressed interest.

MIT in TR ...

When Charles T. Walbridge went to the second Genetic Algorithms Conference at MIT, he had an ulterior motive: he wanted to write an article on the topic for a popular audience. So he took a brief stroll over to *Technology Review's* offices and queried us. The result is on page 46.

Lowell Turner's article (page 38) comes to the magazine through MIT alumnus John Zysman, a co-director of the Berkeley Roundtable in International Economy (BRIE). Preparing to publish one perspective on work at the NUMMI automobile plant in California ("Management by Stress," October 1988), TR editors wanted to explore another point of view as well. Zysman suggested that we speak with Turner, who was a BRIE research associate at the time.

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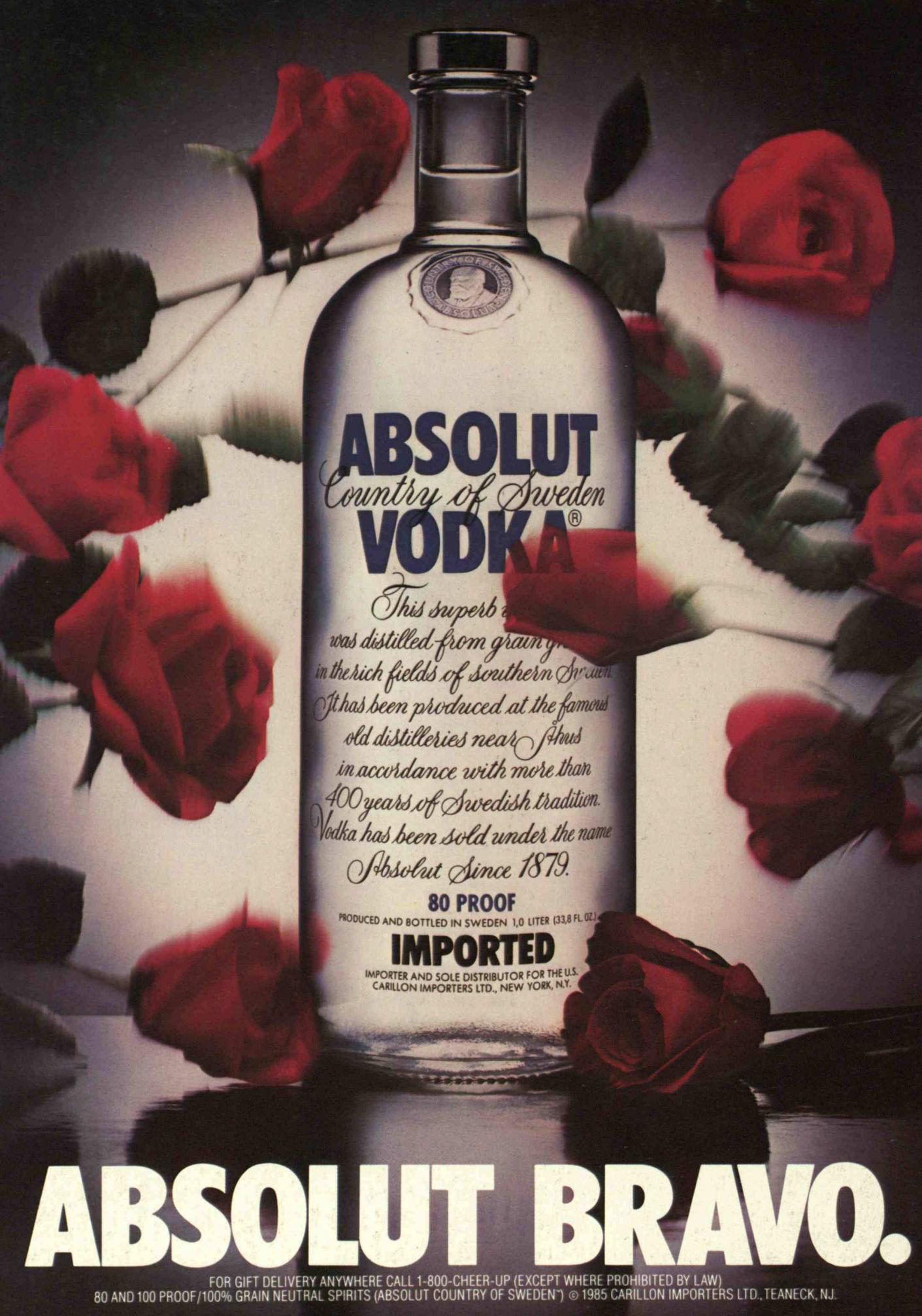
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